VEGETATION CLASSIFICATION AND THE EFFICACY OF PLANT DOMINANCE-BASED CLASSIFICATIONS IN PREDICTING THE OCCURRENCE OF PLANT AND ANIMAL SPECIES

A Dissertation

by

JAMES HUGH YANTIS

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2005

Major Subject: Wildlife and Fisheries Sciences

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Approved by:

Chair of Committee,	Nova J. Silvy
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	William E. Grant
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ABSTRACT

Vegetation Classification and the Efficacy of Plant Dominance-Based Classifications in Predicting the Occurrence of Plant and Animal Species. (August 2005)

James Hugh Yantis, B.A., The University of Texas at Austin;
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One strategy for conserving biodiversity is to select large-area preserves that complement each other so the maximum number of species is conserved. Estimates of biodiversity and complementarity are needed for optimum selection of preserves. Comparisons are made in part by defining and mapping vegetation associations under the assumption that candidate areas with no associations in common likely have high complementarity. Conversely, areas with many associations in common have low complementarity. Vegetation associations are often distinguished on the basis of the dominant plant species. Associations with markedly different dominants (e.g., evergreen and deciduous trees) are expected to indicate high complementarity.

In this study I evaluated the complementarity of an evergreen forest and a deciduous forest. I also evaluated a dichotomy of subsoil texture. I compared 6 groups of species: (1) woody plants (*Dicotyledonae*), (2) birds (*Aves*), (3) small mammals (*Mammalia*) plus herptiles (*Amphibia*) and (*Reptilia*), (4) beetles

(*Coleoptera*), (5) ants (*Formicidae*) plus velvet ants (*Mutillidae*), and (6) spiders (*Araneae*). I made the comparisons using canonical correspondence analysis (CCA), redundancy analysis (RDA), logistic regression, and 3 indices of biodiversity.

In this study the species of dominant tree was more strongly associated with the distribution of species than was soil texture. Dominant tree and soil texture used together greatly improved the association with the distribution of species. The association defined by the dominant evergreen tree was not different than the association defined by the dominant deciduous tree, based on the criteria that an association is defined as having a Jaccard similarity index between 0.25 and 0.5. Similarities >0.5, as in this case, are too similar to be an association and are termed a subassociation.

Evergreen forests and deciduous forests do not necessarily have high complementarity. Different dominant plant species do not necessarily define different associations. Dominant plant species are not necessarily useful in defining associations or higher-level classifications.

DEDICATION

This dissertation is dedicated to my loving wife, Shirley Beaman Hosea Yantis, who conducted every survey and procedure with me, slept in a hot or rain-soaked tent, arose at 0300 hr to do bird surveys, worked each day from well before daylight to well after dark, and, most importantly, picked the really big wolf spiders out of the pitfall traps when I was afraid to do it.

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I thank Michael T. Longnecker for his time and patience in explaining and reviewing the statistical procedures. I thank Charles T. Hallmark for allowing me to use his research lab to analyze the soil samples. I thank David Synatzske and the Texas Parks and Wildlife Department (TPWD) for allowing me to use and publish data from Chaparral Wildlife Management Area.

I thank Nova J. Silvy for his steady support and encouragement for many years. I thank R. Douglas Slack, William E. Grant, Fred E. Smeins, and Robert H. Benson for the discussions, encouragements, constructive criticisms, and for directing me to people, resources, and publications that helped me more fully understand the field of ecology.

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INTRODUCTION

Clements (1936:271) stated it is an axiom that the life-form of the dominant trees stamps its character upon forest and woodland. Whittaker (1973*a*:394) stated dominance-type is not and cannot be a standardized kind of community unit. Which is it? This study considered that question as it relates to the conservation of species and species diversity.

The term *species diversity* or *biodiversity* as used herein applies to the total number of species in the world extant in their natural habitat, or to a smaller area if specified. The term *conservation* as used herein applies to the protection and maintenance of species in their natural habitat.

Study Objective

This study assumes a substantial portion of people believe the conservation of biodiversity is important. The overall goal of this study was to add information that would help preserve biodiversity. Specifically the objective was to provide information to help optimize the classification and mapping of ecological associations for the conservation of biodiversity. This study compared 2 vegetation classifications of the same upper-hierarchical level (the *Formation Subclass* of the United Nations Educational, Scientific, and Cultural

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This dissertation follows the style and format of the Journal of Wildlife Management.

Organization [UNESCO 1973]) to determine if and to what degree these 2 classifications separate species and groups of species. The study made the same determinations for a dichotomous division of subsoil texture. The study determines which one of these classification methods (vegetation or soil) had a greater degree of separation of species or species groups, and if the classification methods augmented each other.

Null hypotheses were: (1) species and species groups are not associated with the vegetation subdivisions, (2) species and species groups are not associated with the soil subdivisions (3) classification based on soil does not have a higher degree of separation of species and species groups than does the classification based on vegetation, and (4) classification based on soil does not augment the classification based on vegetation.

Conservation Strategy

A major theme of this study is the need for parsimony, efficiency, and optimization in biological conservation. Alluding to the role of species in conservation, Leopold (1970:190) stated the first precaution of intelligent tinkering is to keep every cog and wheel. Efforts to conserve species have been undertaken focusing on 1 species at a time, and this approach will continue. But it is not clear if the conservation of keystone or indicator species will conserve the majority of species (Landress et al. 1988, Simberloff 1997, Andelman and Fagan 2000). In any case, if species are to be conserved in their natural habitat, the habitat must be conserved.

Each species may occur in a different ecological association (herein ecological association is a general term analogous to vegetation association but includes animals and all abiotic factors). Because of competing land uses, not all ecological associations can be conserved. Parsimony requires the total amount of ecological associations conserved protects the most species (Noss 1983, Margules et al. 1988, Pressey et al. 1993, Scott et al. 1993, Noss 1996). Some species require a large, contiguous area (millions of hectares) to maintain a stable, secure population (Gurd et al. 2001, Schonewald 2003). Other species require a network of large corridors (each several kilometers in width and many kilometers in length) in order to maintain a secure metapopulation of interacting populations (Harrison 1992).

Under the assumption that ecological associations can be classified within a natural hierarchical framework, and this classification will separate species into reasonably distinct groups, the strategy is to determine these ecological associations, map them, and locate large areas containing each type in a reasonably natural condition. These representative areas, along with needed corridors, would then be prioritized as to their contribution to conserving global species diversity, and subsequently protected through purchase, easement, or other agreement.

Species Concepts and Considerations

Ecological associations throughout the world are placed within a hierarchical framework, with the most inclusive classes at the highest levels. Lower levels are placed within the appropriate next highest level without overlap, down to the lowest level. One entity (UNESCO 1973) provides such a classification system. This system was modified by Driscoll et al. (1984) for the United States. The system was further modified or described by the Federal Geographic Data Committee in 1997 and the Ecological Society of America Vegetation Classification Panel in 2004 (not cited because hard copies are not readily available. Electronic copies are available). The Nature Conservancy (1998) contains approximately the same information and is available in hard copy as cited herein.

Such classifications can be used for: (1) managing and extracting resources such as forest products, (2) preservation of areas of public interest such as tallgrass prairie, and (3) facilitating ecological or ecosystem research and management by consolidating vegetation associations or communities having essentially the same states, functions, flows, and pathways (e.g., mass/ha of the same dominant species).

Because vegetation association classifications for any of the above 3 purposes are often considered synonymous with classifications for the conservation of species diversity, it is important to note they are not. A classification based on dominant plant species, other plant species, and some physical variables, and then subsequently validated by ground-truthing those same criteria indicates only that mapping based on those criteria likely could be done. No conclusions should be inferred immediately concerning mapping of the majority of other species. Yet species may be the most fundamental and important criteria as mentioned earlier (Leopold 1970:190) and should be classified and mapped based on variables that provide the most distinct and reliable groupings of all species.

If the purpose of a classification is to facilitate the conservation of all species, and the classification is based in part on plant species, or on vegetation characteristics, then the classification must be validated based on non-plant species. This study examines validation by non-plant species as well as by plant species.

Complementarity--Conserving an area because it has the highest species diversity is not necessarily the optimum strategy for 2 reasons. One reason is because such areas may be ecotones. Ecotones are good places for public parks because of the diversity of species visitors can see. But ecotones can be precarious with shifting boundaries and low productivity because of increased predation, parasitism, and disease (i.e., may be a sink where populations are being maintained from the interior of the adjacent areas). The other reason is because 2 different areas may each have high species diversity, but their 2 species assemblages may be essentially the same and add few species to the overall goal of conserving regional and global species diversity.

Each area selected as a conservation area should complement other areas chosen in the sense of adding the most species to regional diversity (Pressey et al. 1993, Colwell and Coddington 1994). One corollary of this optimization is that areas should not be chosen until all have been evaluated and the best set then conserved. Unfortunately in practice, areas have been selected historically, often ecotones, and the next best strategy is to fill in the gaps (Pressey et al. 1993, Scott et al 1993).

Species types and groups--Several dichotomies can be applied to species: common or rare, restricted or wide-ranging, increasing or declining, exotic or native. These terms can be important when evaluating the diversity and complementarity of an area or an ecological association. Species that are common, wide-ranging, increasing, or exotic may inflate the estimate of diversity and weaken the estimate of complementarity of an area or ecological association. This is especially true of exotics. The term exotic does not apply to political boundaries. An exotic is any species that does not naturally occur in an area. A species may be a State flower, but if it is brought into an area of the State where is did not occur naturally, it is an exotic in that area. If a species historically occurred in an area in very low numbers, and then increased with changes, it is an increaser not an exotic, and is a valid part of the area. But if exotic, usually it should not be part of a diversity index.

Concerning the other types mentioned (common, wide-ranging, increasing), the decision to include these types in a diversity index should be made on a case basis. The investigator should be aware that including these species in a comparison of diversity and complementarity might weaken the ability of the comparison to select the areas that will result in optimum conservation of regional and global diversity.

Species may be grouped in various ways (e.g., taxonomic, type of feeding, mass, vertical strata where found). Any number of types of groups could be conceived. This is worrisome because ecological associations cannot generally, if ever, be exhaustively inventoried. In practice the investigator selects groups that can be inventoried as fully as possible. It is likely the selection of a different set of groups would result in a different diversity index. Selecting the same groups in every case does not solve the problem because the number of species in a group changes in different areas, and not necessarily as a function of overall (true, complete) diversity.

Variables other than vegetation species--Physical variables other than vegetation species are often used as primary or secondary variables in mapping associations. Fundamental variables include the means and extremes of moisture, temperature, and sunlight (insolation) (Schouw 1823 *in* Holdridge 1967:11, Chapman 1926). Surrogates used in place of these variables often include: latitude, elevation, slope aspect, topographic position, soil texture (or other soil measurements), and vegetation structure (vegetation structure internally influences the levels of the fundamental variables) (Franklin

1995). An important variable, not necessarily a surrogate for the fundamental variables, is relative location (a concept of biogeography) (McLaughlin 1992).

Some variable combinations can be redundant and may not be parsimonious. This study examines the optimization of the variables used for classification if the purpose is the conservation of species and species diversity.

STUDY AREA

Area

Location and boundaries--The study area was located in east Texas and contained parts of 7 counties: Anderson, Grimes, Houston, Leon, Madison, Trinity, and Walker (Fig. 1). The study area was contained within a southwest to northeast oriented polygon approximately 100 km X 120 km. The east boundary was longitude 95°07.5'W. The west boundary was longitude 96°15.0'W. The north boundary was the north boundary of the Queen City Sand geologic formation, and the south boundary was the south boundary of the Caddell Formation (Bureau of Economic Geology undated). These formations are oriented southwest to northeast, thus the study area was approximately a parallelogram. The other 5 geologic formations within the study area are: Weches Formation, Sparta Sand, Stone City Formation, Cook Mountain Formation, and Yegua Formation (Bureau of Economic Geology undated).

Divisions--The study area was divided north and south by the contact line between the Sparta Sand and the Stone City Formation, or if the Stone City Formation was absent, between the Sparta Sand and the Cook Mountain Formation. This divides the study area into a northern portion (Queen City Sand, Weches Formation, and Sparta Sand) with subsoils potentially dominated by sand or sandy loam, and a southern portion (Stone City

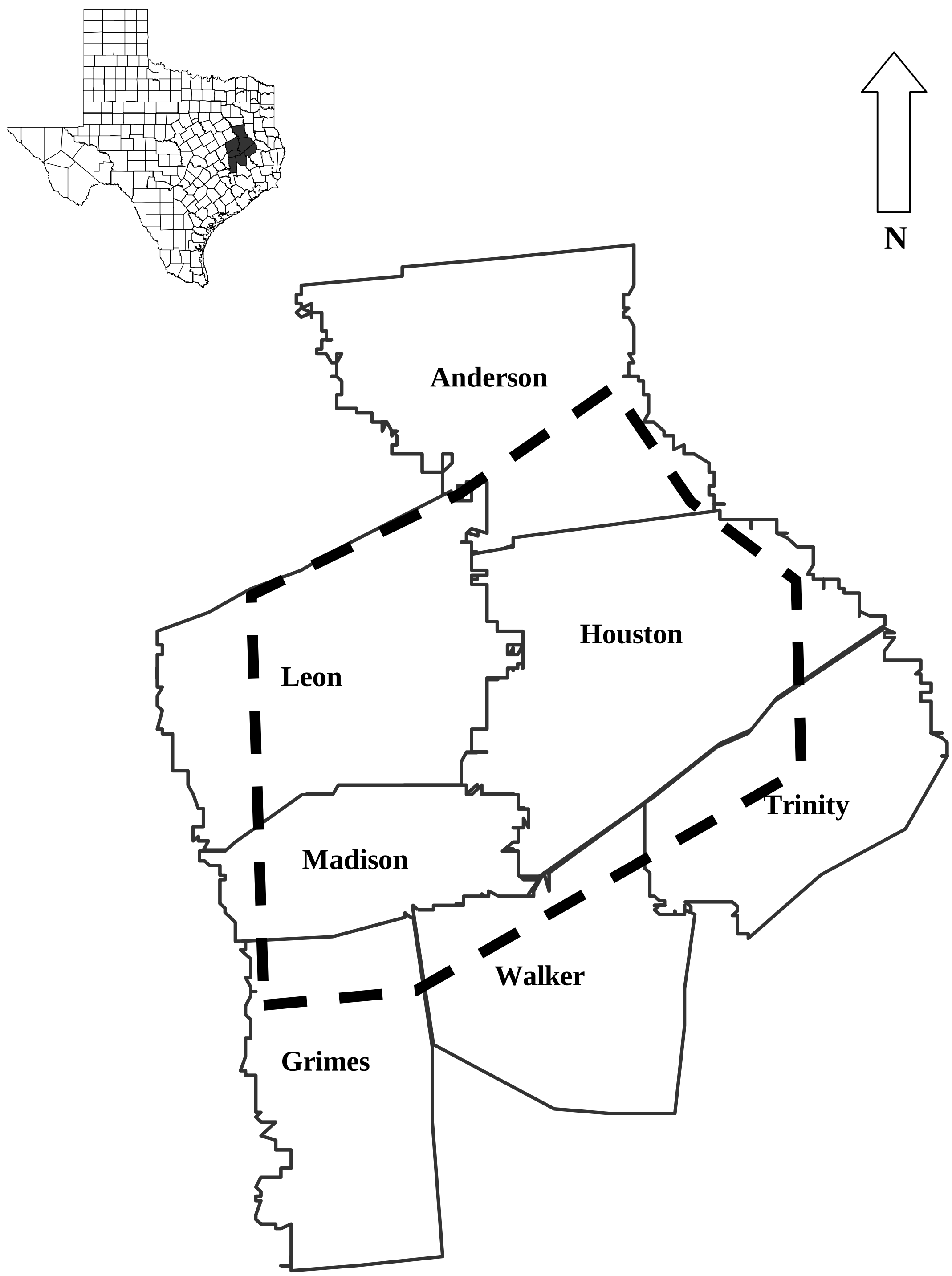


Fig. 1. Study area in east Texas comparing pine and post oak forest (within dashed line).

Formation, Cook Mountain Formation, Yegua Formation, and Caddell Formation) with subsoils potentially dominated by clay loam or clay subsoils.

The study area was divided east and west by longitude 95°46.3'W. West of this dividing line all of the randomly selected upland forest research plots were dominated by an overstory of post oak (*Quercus stellata*). East of this dividing line all of the randomly selected upland forest research plots were dominated by an overstory of loblolly pine (*Pinus taeda*) and or shortleaf pine (*P. echinata*). This dividing line was approximately the same as the centerline of the Trinity River floodplain, except the river and floodplain curve to the southeast near the southern boundary of the study area. All of the plots dominated by post oak were west of the Trinity River. All of the plots dominated by pine were east of the Trinity River except 2 near the southern boundary of the study area.

Strata--The above north-south and east-west divisions divided the study area into 4 quadrats (not necessarily equal in size). These quadrats were used as strata for stratified random sampling. These strata potentially indicate areas of particular combinations of dominant tree species and subsoil texture (e.g., pine-sand, pine-clay, post oak-sand, post oak-clay).

Elevation and climate--The study area varies approximately from 50–200 m above mean sea level. The randomly chosen upland forest plots vary approximately from 75–150 m above mean sea level. Overall the drainage is to the south toward the Texas coast, but locally may be in any direction. Prevailing winds are from the southeast in summer, and about evenly divided from north and south in winter. The first freeze is usually in late November and the last usually in early March. Summer temperatures often exceed 35 °C.

From the east boundary to the west boundary of the study area there is a gradient of increasing aridity. Interpolating from climate maps (Bureau of Business Research 1976): (1) the east boundary mean summer drought length was 20 days and the west boundary 33 days, (2) the east boundary mean annual precipitation was 117 cm and the west boundary 102 cm, and (3) the east boundary mean annual evaporation rate was 30 cm and the west boundary was 51 cm.

From the south boundary to the north boundary there was a slight decrease in temperature and length of growing season. For the south boundary the mean annual temperature was 20 °C and the north boundary was 19 °C. For the south boundary the mean length of the warm season was 275 days and the north boundary was 260 days.

Plot Selection

Herein a tract is a parcel of land of many hectares owned by 1 person or entity. A site is within a tract and is a contiguous, non-linear area of many hectares containing or potentially containing a research plot. Herein site is a more inclusive term than forest stand. There is 1 and only 1 plot in each selected research site. A plot is a named and precisely located center-point, radius, and area. For vegetation the area was 1 ha. The same plots, by name, were used for animal species, but the interpretation of radius and area may be different for different animal groups.

Sampling protocol--Spatially systematic, random sampling was used. A set of 7.5' topographical maps (U.S. Geological Survey undated) was obtained to cover the study area. Each topographic map, except 1, indicated wooded areas in solid green, brush in stippled green, and open areas not colored. An x, y-coordinate system in numbered 1.27-cm intervals was applied to each topographic map. An x and y value was randomly chosen for each map and the intersection noted on the map. From that point the nearest wooded tract was chosen for a plot provided the tract was not rejected (see below).

Qualifications for tract inclusion were: (1) the tract was upland, (2) the wooded area had a minimum width of 300 m, (3) the landowner granted permission for access and research, and (4) the wooded area contained mature post oak or pine trees appearing to be at least 50% of the canopy cover and mostly greater than 25-cm diameter at breast height (i.e., of mature, fruit-bearing age). Black-and-white and infrared maps from any locally available source were used to help make the decision regarding the forest type and maturity. Cursory ground reconnaissance was done if the maps did not provide a convincing answer. If a tract was chosen (i.e., not rejected), the selection criteria were confirmed empirically during the research phase.

Landowner permission--The landowner's name and address were obtained from maps at the County Tax Assessor's office, and a letter requesting permission to do forest research was sent to the landowner. If a phone number could be found, the landowner was phoned a week later. If the landowner did not reply after a second letter or could not be contacted, or if the landowner refused access, the next nearest wooded tract from the original random point, with a different owner, was selected and the process repeated.

Land use and rejected areas--Of the tracts appearing to qualify as potential study sites, there was no noticeable difference between those where the landowner granted permission compared with those where the landowner could not be contacted or did not grant permission.

Some large areas covering several topographical maps were in open pasture or cropland. These areas were mostly on the floodplain and terraces of the Trinity River, and near the largest towns. Because these areas were not included in the random sampling (not forested) it is possible and likely these areas have different soils than typical of the study area. Similarly, forest types in flood plains, or in various seral stages, or in the distant past are not included in the random sampling.

None of the above situations appear to compromise the findings, interpretations, or applications of the study. The study is concerned with measured conditions and relationships as they were at the time of the study, or as possibly may be projected into the future.

Site selection and access difficulties--Initially 1 site per 7.5' topographic map was the study goal, for approximately 80 plots. This goal was not met with the first year of effort (1995) because of: (1) the large areas of unsuitable vegetation, (2) the large number of absentee landowners that could not be reached (many living in other states or countries), and (3) the refusal of landowners to grant access and permission for research.

Many Texas landowners would not allow on their property, any person affiliated with any organization investigating wildlife or wild plants. Texas, by statute, prevented TPWD from releasing any information about wildlife or plants that could be traced to a particular tract of land. This restriction applied to me because I was employed at TPWD while I was doing the field work for the present study. Each participating landowner was given a signed letter assuring the landowner no information would be linked to their property. Consequently no information pertaining to the location of research plots was or will be reported at an accuracy that would locate a plot closer than 1–2 km. This has no bearing on the findings, but future comparisons can only be made with similar stratified random sampling and protocol (i.e., not by paired comparisons).

It would have been easier to obtain the permission, access, and the number of plots needed if known willing cooperators had been contacted, or if cooperators had been solicited in local newspapers. But willing or eager cooperators may have purchased property because of its existing high wildlife diversity, or have done some wildlife and wild plant conservation practices. The extent to which an abundance of such situations would bias the findings was unknown. A few of the randomly selected tracts had been purchased for their wildlife value or were managed for wildlife and wild plants, but the number of such situations did not seem out of proportion with the number of such tracts in the whole population of tracts.

Conceptually, 1 purpose the study was to evaluate the mean or overall conditions as they were at the time the vegetation types were investigated. The sampling protocol and modifications were designed to meet that purpose.

Protocol modifications--In order to obtain the desired number of sites, the sampling protocol was modified the second year (1996). A 7.5' topographic map was chosen at random from each of the 4 strata. Each topographic map was divided into 9 subquadrats of 2.5' X 2.5'. A random point was selected in each topographic map as before, but with the constraint that if the random point was in the same subquadrat as a previously selected site, another random point was selected that was not in a previously selected subquadrat. This process (selecting 4 topographical maps at a time 1 from each stratum) was repeated until an adequate number of sites was selected (but see below)

Each selected site was visited and preliminary data obtained on the canopy cover of the dominant tree species by ocular estimate, and on subsoil texture by feel. These preliminary data indicated the geology was not a perfect predictor of subsoil texture. A decision was made to select the last 3 sites, from a set of 6 randomly chosen sites, so there would be an equal number of sites in 4 strata (pine-sand, pine-clay, post oak-sand, post oak-clay).

Thus, the strata and the study were based on empirical measurements of dominant tree species and subsoil texture, and not on geology or a defined area. No other modifications were made to the site-selection protocol except as just described. Although some sites occur unexpectedly in some geologic formations (e.g., a clay subsoil in a sandy geologic formation), these exceptions are few and there remains a strong relationship between geology and subsoil texture.

Precise plot location--At the end of the second year, 60 sites had been chosen (15 in each empirically defined stratum). All study findings are based on these 60 sites. Within each site, 1 and only 1 plot was selected and all measurements taken were within that plot. For each plot the same measurements were taken.

Plots were located by a subjective and a random component. The randomly-selected site was accessed by the easiest route. At the first contact point with the site, a direction and distance into the site were randomly chosen. The random direction was a bearing plus or minus 20 degrees from a centerline perpendicular to the perceived tangent to the site at the first contact point. The random distance was 100–400 m. The distance was paced to the plot center-point using a hand-held compass. If that plot location was not rejected (see below), it was selected, named, marked with an orange stake, and the coordinates (Table 1) determined with a hand-held geographic positioning system receiver (GPS) and a red X drawn precisely at the plot center on a 7.5' topographic map.

Qualifications for plot inclusion were: (1) more than 100 m from a public road, (2) more than 100 m from bottomland (alluvial) soil, (3) dominated by pine or post oak of reproductive age, (4) no natural openings >0.1 ha, (5) no permanent pond or perennial stream within the 1-ha boundary, (6) not drastically aberrant from a natural situation. Aberrant would include, among other things, the presence of oil wells, wildlife food plots, high-traffic logging roads, and obvious use of pesticides. If a plot was rejected, a new location was chosen 100 m in a random direction conditional on being away from the aberrant situation or activity, and moved again from there if necessary. There were no instances where a plot could not be properly located in a selected site, and <5 instances where the first plot selection was not appropriate.

Ecological breadth of plots selected--Although a stated purpose of the study was to investigate the defined vegetation types, this was not construed too restrictively at the plot level. Conceptually, the approach was to encompass the range of situations that normally would occur in a defined vegetation type as it might, for example, be mapped using satellite imagery, and or conserved and managed as a larger unit such as a forest stand. The application of this concept meant some plots were selected that might not precisely meet the requirements of canopy cover. This situation rarely

Table 1. Plot location (Lat, Long)[a] and starting date for vertebrate surveys for an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

Plot[b] name	Lat deg	Lat min		Long deg	Long min	Starting bird survey date			Starting herp array date			Starting Sherman trap date		
1	31	45.61	,	95	29.93	1	Jun	2000	17	Jun	2002	23	Jun	2002
2	31	49.00	,	95	24.89	31	May	2000	15	Jun	2002	30	May	2000
5	31	42.69	,	95	26.57	17	Jun	1996	11	Jun	2002	18	Jun	2002
6	31	45.30	,	95	23.33	28	Jun	2000	13	Jun	2002	18	Jun	2002
7	31	35.93	,	95	38.89	21	Jun	1997	1	Oct	1996	1	Nov	1996
8	31	34.93	,	95	28.33	19	Jun	1997	1	Nov	1996	1	Nov	1996
10	31	39.12	,	95	19.36	28	Jun	1996	15	Jun	2002	18	Jun	2002
12	31	32.56	,	95	55.53	19	Jun	1999	2	May	2002	5	May	2002
16	31	26.35	,	96	08.83	11	Jun	2001	26	Apr	2002	10	Jun	2001
17	31	30.52	,	95	16.79	11	May	1997	21	May	2002	22	May	2002
18	31	29.89	,	95	13.00	22	May	1997	27	May	2002	20	May	1997
19	31	22.42	,	95	56.97	14	Jun	2001	11	Sep	2001	13	Jun	2001
20	31	23.21	,	96	05.44	5	Jun	1999	17	Sep	2001	22	Sep	2001
21	31	27.39	,	95	54.28	30	Jun	1999	1	May	2002	3	May	2002
22	31	26.75	,	95	46.63	27	Jun	1999	5	May	2002	5	May	2002
24	31	23.88	,	95	36.54	7	May	1997	17	May	2002	6	May	2000
25	31	18.97	,	95	35.60	4	Jun	2001	9	May	2002	3	Jun	2001
26	31	27.74	,	95	20.84	8	Jun	2000	21	May	2002	7	Jun	2000
27	31	24.96	,	95	17.83	23	May	1997	19	May	2002	30	May	1997
28	31	24.21	,	95	09.74	20	Jun	1997	2	Jun	2002	12	Jun	2002
29	31	20.90	,	96	07.89	12	Jun	2001	24	Apr	2002	11	Jun	2001
30	31	16.26	,	96	00.13	18	Jun	2001	10	Sep	2001	16	Jun	2001
31	31	16.97	,	95	57.68	14	Jun	1999	9	Sep	2001	12	Sep	2001
34	31	11.75	,	96	04.80	15	Jun	2001	17	Apr	2002	14	Jun	2001
37	31	22.35	,	95	20.66	6	Jul	1998	27	May	2002	31	May	2001
38	31	20.60	,	95	13.65	9	May	1997	22	May	2001	18	May	2001
39	31	16.14	,	96	10.70	5	Jul	1996	5	Apr	1996	15	Apr	1996
40	31	10.89	,	95	58.74	19	Jun	2001	12	Sep	2001	18	Jun	2001
41	31	15.53	,	95	52.72	16	Jun	1996	4	Sep	1996	4	Sep	1996
45	31	13.51	,	95	20.85	22	Jun	2000	7	May	2001	2	May	2001
46	31	11.78	,	95	21.27	30	Jun	2000	7	May	2001	3	May	2001
47	31	14.99	,	95	16.76	8	May	1997	25	May	2001	7	May	1997
48	31	15.29	,	95	10.01	3	Jul	1999	17	May	2001	18	May	2001
50	31	05.82	,	96	03.30	6	Jul	1996	8	Apr	1996	8	Apr	1996
51	31	09.50	,	96	02.47	20	Jun	2001	14	Sep	2001	19	Jun	2001
52	31	14.69	,	95	50.87	30	Jun	2001	14	Apr	2002	27	Jun	2001
53	31	12.43	,	95	47.98	25	Jun	2001	15	Apr	2002	24	Jun	2001
56	31	09.99	,	95	26.36	15	Jun	2000	24	Apr	2001	24	Apr	2001
58	31	10.12	,	95	09.08	18	Jun	1997	14	May	2001	17	Jun	1997
59	31	04.84	,	96	09.06	11	Jun	1999	27	Sep	2001	5	Oct	2001
60	31	00.77	,	96	07.81	10	Jun	1998	28	Sep	2001	11	Jun	1998

Table 1. Continued.

Plot[b] name	Lat deg	Lat min		Long deg	Long min	Starting bird survey date			Starting herp array date			Starting Sherman trap date		
62	31	04.98	,	95	47.36	29	Jun	2001	15	Apr	2002	27	Jun	2001
66	31	03.31	,	95	26.36	14	Jun	2000	20	Apr	2001	30	Apr	2001
67	31	00.35	,	95	21.60	28	May	2001	20	Apr	2001	20	Apr	2001
68	30	57.08	,	96	09.39	5	Jul	1997	31	Mar	2002	6	Jul	1997
73	30	51.85	,	96	06.12	1	Jun	1998	23	Mar	2002	1	Jun	1998
74	30	54.90	,	95	55.98	22	Jun	2001	28	Mar	2002	23	Jun	2001
75	30	52.89	,	95	54.36	27	Jun	1998	1	Oct	2001	15	Oct	2001
77	30	54.84	,	95	46.17	29	Jun	1998	23	Sep	2001	26	Sep	2001
78	30	49.32	,	96	06.50	6	Jul	1997	22	Mar	2002	24	Mar	2002
79	30	47.87	,	96	02.85	2	Jun	1998	9	Oct	2001	1	Jun	1998
82	30	43.96	,	96	06.49	28	May	2000	25	Mar	2002	27	May	2000
83	30	44.33	,	95	57.83	29	May	2000	26	Mar	2002	25	Mar	2002
84	30	43.81	,	95	54.59	21	Jun	2001	1	Oct	2001	27	Mar	2002
85	30	51.20	,	95	36.98	21	Jun	2000	9	Apr	2002	21	Jun	2000
87	31	01.00	,	95	16.31	31	May	2001	21	Apr	2001	21	Apr	2001
88	31	07.31	,	95	12.49	1	Jun	2001	26	Apr	2001	29	Apr	2001
90	31	33.40	,	95	09.62	9	Jun	2000	5	Jun	2002	12	Jun	2002
91	31	28.22	,	95	08.00	29	Jun	2000	3	Jun	2002	12	Jun	2002

[a] Lat, Long locations are degraded to be within 1 to 2 km of the actual location in accordance with Texas law that stipulates the location of plant and animal species may not be associated with a particular ownership if the survey used any State equipment, funds, or other resources.

[b] Plots are not consecutively numbered, but rather the plots are named by number.

occurred, but when it did it was because: (1) the plot contained several beetle or drought killed trees, (2) the plot contained a natural opening, or (3) the plot was adjacent to an upland stream or pond.

A natural opening as defined herein: (1) had an irregular boundary, (2) had full sun at least at the center most of the day, (3) had vegetation native to the general area, (4) was of uncertain origin, or was an edaphic anomaly, or was a shallow depression occasionally holding water in the growing season but only long enough to suppress woody vegetation, and (5) was not >0.1 ha.

Small flowing streams (without alluvial soils) and small permanent ponds are a natural feature and an integral part of an upland pine or post oak forest. But if a flowing stream or pond was contained within a selected plot, the plot center was moved directly away from the stream or pond so the outer perimeter of the plot would be 5–10 m from the cutbank of the creek or the normal high-water line of a pond. In this way no strictly aquatic plants or animals were recorded.

Drainage ways that only flowed a few hours after a rain, and low areas that only filled for a few days after a rain were considered part of the plot and the plot location was not adjusted. Any local (within plot) soil anomaly also was considered an integral part of the plot (discussed in an earlier section on methods). Any animals or plants in such situations were collected or measured the same as the rest of the plot, and no notation was made as to difference in the environment (i.e., the plot was treated conceptually as uniform or as a mean of the variables measured).

If a plot contained beetle-killed or drought-killed trees, or contained an opening, the canopy cover of pine or post oak (and total canopy) was reduced directly. If the plot was near a flowing stream or permanent pond, the canopy cover of pine or post oak was reduced, sometimes, if part of the canopy was taken by tree species associated with streams or ponds. In this situation, the total canopy cover was not reduced.

All of the situations allowed in selected plots, as discussed in this section on ecological breadth, are considered to be an integral part of the post oak and pine forest. The reason for using the relatively large plot size of 1 ha was to ensure the diversity of the defined vegetation types was captured. If a plot did not appear to meet the criteria exactly, but was an integral and continuous part of a forest stand that did meet the criteria, the plot was allowed (selected). The actual measurements taken on the plots identify the characteristics of the individual plots.

METHODS

The same measurements of environmental variables (Table 2) and species presence or absence (Appendices A–F) were taken for each of the 60 plots selected as explained in the previous section.

Plot Design

From the plot center-point, beginning with a random direction, 6 rays each 62 m in length were constructed at 60º angles. The ends of the rays were marked with an orange stake or flag, creating a hexagon with an area of 1 ha. The straight boundary lines facilitated the determination if a plant was in the plot or not. The largest distance to the boundary from the hexagon center was 62 m. The smallest distance was 53.7 m. The radius of a 1-ha circle is 56.4 m. For future reference, the first ray chosen and 2 other rays at 120º angles are hereafter called the primary rays. The 3 rays in between those are called the secondary rays simply to have a useful label.

Environmental Variables

Seventeen environmental variables were measured or estimated. These environmental variables (also called factors, but this does not imply causation, only association) are explained and defined in the paragraphs below. Brief descriptions and the factor abbreviations used herein follow now:

Table 2. Values by plot of 20 environmental variables (factors) as measured in 60 1-ha plots in upland forest of east Texas during the period 1 March 1996 to 31 October 2002. Plots are not consecutively numbered, but rather are named by number. See footnotes for factor names and descriptions; and Table 1 for plot locations.

Plot	Pi[a]	Sa[b]	PB[c]	KB[d]	AB[e]	psa[f]	psi[g]	pcl[h]	vsn[i]	vsk[j]	GC[k]	op[l]	gz[m]	bn[n]	pcp[o]	drt[p]	BD[q]	HD[r]	DT[s]	TreeSpecies[t]
01	1	1	16.5	2.4	19.9	93.1	5.5	1.4	15.3	13.0	2	1	0	0	107	23	70	88	0.571	Shortleaf pine
02	1	0	31.0	0.0	38.8	50.5	31.9	17.6	19.4	14.8	2	1	0	1	107	23	69	86	0.838	Loblolly pine
05	1	1	18.2	0.0	18.2	94.8	3.4	1.8	15.9	15.2	2	1	0	0	109	23	86	82	0.508	Sweetgum
06	1	1	20.5	0.0	20.5	87.9	7.7	4.4	18.4	14.6	3	1	0	0	109	23	97	84	0.419	Loblolly pine
07	1	1	13.0	4.7	21.6	89.9	7.8	2.3	24.1	16.9	2	1	0	0	104	25	90	194	0.698	Sweetgum
08	1	1	23.6	1.5	34.4	85.1	12.4	2.5	30.1	17.1	1	1	3	0	107	23	88	225	0.711	Loblolly pine
10	1	1	22.7	0.0	22.7	71.2	23.4	5.4	11.4	6.8	1	1	0	1	109	20	97	86	0.355	Loblolly pine
12	0	1	0.0	14.9	19.4	91.8	7.0	1.2	20.2	16.5	1	1	1	0	104	31	88	42	0.660	Post oak
16	0	1	0.0	20.7	25.3	92.7	4.8	2.5	16.5	12.8	1	1	1	0	102	35	80	36	0.698	Post oak
17	1	1	16.6	0.1	18.9	83.6	13.9	2.5	14.3	10.5	2	1	0	2	109	20	49	61	0.673	Shortleaf pine
18	1	1	30.0	3.9	38.0	87.2	10.8	2.0	15.2	12.9	2	1	0	1	109	20	60	67	0.685	Shortleaf pine
19	0	1	0.0	12.2	17.5	93.9	4.3	1.8	20.6	15.7	1	1	0	1	104	31	83	174	0.546	Post oak
20	0	1	0.0	11.8	14.0	92.7	5.8	1.5	22.0	17.9	2	1	1	0	102	32	74	180	0.406	Post oak
21	0	1	0.0	9.2	21.0	84.7	6.9	8.4	22.8	17.7	1	1	1	0	104	29	99	41	0.799	Southern red oak
22	0	1	0.0	9.9	17.8	79.8	18.0	2.2	19.3	15.9	1	1	2	0	104	29	96	45	0.508	Southern red oak
24	1	1	24.9	0.0	25.2	91.5	6.5	2.0	6.7	9.2	1	1	1	1	104	25	45	57	0.825	Shortleaf pine
25	1	0	27.6	0.0	33.1	56.1	14.5	29.4	27.4	16.8	1	1	0	1	104	25	73	49	0.711	Southern red oak
26	1	1	31.5	0.3	37.8	88.5	9.5	2.0	9.7	4.6	1	1	0	2	109	23	77	61	0.850	Shortleaf pine

Table 2. Continued.

Plot	Pi[a]	Sa[b]	PB[c]	KB[d]	AB[e]	psa[f]	psi[g]	pcl[h]	vsn[i]	vsk[j]	GC[k]	op[l]	gz[m]	bn[n]	pcp[o]	drt[p]	BD[q]	HD[r]	DT[s]	TreeSpecies[t]
27	1	0	27.4	0.0	28.8	15.5	32.5	52.0	8.9	8.0	1	1	0	1	109	20	61	59	0.609	Loblolly pine
28	1	1	23.3	1.2	29.3	79.4	16.6	4.0	40.5	21.0	2	1	0	2	109	20	89	73	0.888	Loblolly pine
29	0	1	0.0	10.1	14.3	90.7	7.0	2.3	19.8	14.4	1	1	2	1	99	35	81	34	0.647	Post oak
30	0	1	0.0	5.7	13.4	93.8	4.2	2.0	26.5	15.4	2	1	1	1	102	32	87	173	0.736	Post oak
31	0	1	0.0	20.0	22.2	89.7	8.3	2.0	15.9	12.4	1	1	1	0	102	31	83	172	0.533	Post oak
34	0	1	0.0	23.0	25.3	93.0	3.4	3.6	21.3	17.8	2	1	1	1	99	32	84	27	0.508	Southern red oak
37	1	0	21.9	1.6	23.7	32.8	22.3	44.9	14.0	13.4	2	1	0	0	107	23	105	67	0.533	Southern red oak
38	1	1	33.3	0.0	37.8	78.5	17.4	4.1	7.3	8.3	2	1	0	1	109	20	47	62	0.736	Shortleaf pine
39	0	1	0.0	27.2	29.7	89.1	8.6	2.3	25.5	20.6	1	1	2	0	99	35	104	15	0.596	Post oak
40	0	0	0.0	9.8	20.4	61.3	8.0	30.7	11.2	9.3	3	1	1	2	102	31	88	175	0.863	Southern red oak
41	0	1	0.0	16.0	19.9	92.0	6.0	2.0	36.6	24.9	1	1	1	0	102	29	85	167	0.660	Post oak
45	1	0	16.8	4.2	24.5	30.3	26.3	43.4	25.5	19.0	2	1	0	1	109	23	91	47	0.952	Loblolly pine
46	1	1	28.0	1.2	33.9	75.3	19.8	4.9	15.4	9.6	2	1	0	1	109	23	99	47	0.838	Loblolly pine
47	1	0	37.1	1.2	46.1	49.5	6.0	44.5	21.6	17.3	1	0	0	1	109	23	46	65	0.736	Loblolly pine
48	1	0	14.1	1.4	21.2	54.5	34.8	10.7	26.1	14.5	2	1	0	1	109	20	102	57	0.863	Loblolly pine
50	0	0	0.0	23.3	24.9	26.3	22.3	51.4	23.1	20.0	0	0	3	0	99	32	105	18	0.558	Post oak
51	0	1	0.0	16.4	21.8	86.3	10.8	2.9	18.5	11.1	1	1	2	1	99	32	89	177	0.571	Post oak
52	0	0	0.0	8.7	21.2	55.0	13.5	31.5	13.7	9.1	2	1	2	0	104	29	99	24	0.850	Water oak
53	0	0	0.0	22.8	24.7	18.9	23.4	57.7	22.9	17.4	2	1	2	1	104	27	94	25	0.584	Post oak
56	1	0	12.3	1.2	14.5	57.0	22.9	20.1	12.0	10.2	2	1	0	2	109	23	84	34	0.761	Loblolly pine

Table 2. Continued.

Plot	Pi[a]	Sa[b]	PB[c]	KB[d]	AB[e]	psa[f]	psi[g]	pcl[h]	vsn[i]	vsk[j]	GC[k]	op[l]	gz[m]	bn[n]	pcp[o]	drt[p]	BD[q]	HD[r]	DT[s]	TreeSpecies[t]
58	1	0	24.2	0.0	28.7	53.9	28.4	17.7	12.7	9.2	1	1	0	1	109	20	87	54	0.584	Loblolly pine
59	0	1	0.0	15.7	16.9	94.1	4.3	1.6	19.7	14.6	2	1	1	0	99	35	80	190	0.558	Post oak
60	0	0	0.0	17.2	22.7	40.6	17.9	41.5	18.6	18.5	1	1	1	0	99	33	79	191	0.541	Post oak
61	0	1	0.0	27.0	28.1	76.1	18.8	5.1	22.6	23.0	0	1	3	0	104	30	104	21	0.711	Post oak
62	0	0	0.0	14.5	26.0	35.0	34.2	30.8	17.3	10.6	3	1	1	1	107	29	98	25	0.723	Post oak
66	1	0	22.7	7.1	34.7	61.4	23.4	15.2	10.8	7.1	1	1	0	0	109	25	83	30	0.596	Post oak
67	1	0	24.8	0.0	25.5	54.0	14.3	31.7	16.2	8.9	1	1	0	2	112	23	66	30	0.660	Southern red oak
68	0	0	0.0	15.5	20.3	32.9	14.6	52.5	26.2	39.6	1	1	2	0	99	33	104	10	0.508	Post oak
73	0	0	0.0	16.8	20.0	30.0	16.0	54.0	17.3	16.0	1	1	2	0	102	33	70	2	0.584	Post oak
74	0	0	0.0	6.0	12.4	40.2	23.8	36.0	14.5	14.0	2	1	1	1	104	31	91	7	1.066	Post oak
75	0	0	0.0	16.8	19.7	64.8	26.1	9.1	14.5	13.3	2	1	1	0	107	30	96	194	0.470	Post oak
77	1	0	29.9	7.2	38.6	62.6	24.1	13.3	18.2	19.6	1	1	2	0	109	27	98	186	0.761	Loblolly pine
78	0	0	0.0	12.3	16.7	33.1	16.4	50.5	18.6	14.6	1	1	1	0	102	33	105	1	0.660	Post oak
79	0	0	0.0	14.9	25.0	39.0	22.3	38.7	29.5	22.9	1	1	1	0	102	33	71	202	0.558	Post oak
82	0	0	0.0	15.5	17.0	53.5	26.2	20.3	18.8	15.7	1	1	2	0	102	33	66	4	0.787	Post oak
83	0	0	0.0	14.4	15.3	40.0	18.3	41.7	9.2	7.0	2	1	1	0	107	32	67	5	0.546	Post oak
84	0	0	0.0	17.9	17.9	37.3	18.7	44.0	19.2	15.6	2	1	1	0	109	31	90	194	0.533	Post oak
85	1	0	33.0	4.4	38.4	61.6	13.9	24.5	15.0	12.0	1	1	0	1	112	27	90	19	0.609	Shortleaf pine
87	1	0	28.5	0.0	29.4	43.9	8.1	48.0	15.7	13.7	2	1	0	1	109	27	69	31	0.799	Blackgum
88	1	0	21.5	7.2	32.7	32.7	10.7	56.6	13.3	7.6	2	1	0	1	109	20	70	36	0.558	Post oak
90	1	1	25.0	0.3	34.1	84.0	13.5	2.5	15.3	9.3	2	1	0	0	109	20	78	76	0.736	Shortleaf pine
91	1	1	40.9	0.0	55.0	79.2	18.1	2.7	41.2	39.9	1	0	0	2	109	20	98	74	0.838	Loblolly pine

Table 2. Continued.

[a] Pine1: Dominant tree, categorical: Pine = 1, Post oak = 0.
[b] Sand1: Soil texture (PSD), categorical: Sand1 = 1 if sand >70% (clay <9%), otherwise = 0.
[c] P_BA: Pine basal area in m^2/ha (trees <25 cm diameter breast-high [DBH] not included).
[d] K_BA: Post oak basal area in m^2/ha (trees <25 cm DBH not included).
[e] all_BA: Basal area in m^2/ha for all tree species (trees < 25 cm DBH not included).
[f] pcSand: Percent sand in soil particle size distribution (PSD).
[g] pcSilt: Percent silt in soil PSD.
[h] pcClay: Percent clay in soil PSD.
[i] VisNeck: Understory density as measured by distance to visual obstruction at height of 1.5 m.
[j] VisKnee: Understory density as measured by distance to visual obstruction at height of 0.5 m.
[k] GrndCov: Ground cover by ocular estimate (0-3), where 3 is most dense.
[l] opening: A natural full-sun opening >0.1 ha present in plot: yes = 1, no = 0.
[m] GrzClass: Grazing pressure by ocular estimate (0-3), where 3 is most grazed.
[n] BrnClass: Past fire frequency and intensity by ocular estimate (0-3), where 3 is most obvious (recent or intense).
[o] precip: Annual precipitation in cm (interpolated from precipitation map).
[p] drought: Number of consectutive summer days with no appreciable rain (interpolated from map).
[q] BirdDay: Date of bird survey as indicated by consecutive day, where day 1 is 22 March, regardless of year.
[r] HerpDay: Date of herp survey as indicated by consecutive day, where day 1 is 22 March, regardless of year.
[s] DiaLargTree: DBH in m of largest tree in plot.
[t] TreeSpecies: Species (by common name) of largest tree in plot.

(1) dominant tree (Pine1), (2) subsoil texture (Sand1), (3) basal area pine (P_BA), (4) basal area post oak (K_BA), (5) basal area all trees (all_BA), (6) percent sand in subsoil (pcSand), (7) percent silt in subsoil (pcSilt), (8) percent clay in subsoil (pcClay), (9) visibility 0.5-m height (VisKnee), (10) visibility 1.5-m height (VisNeck), (11) ground cover (GrndCov), (12) opening presence (opening), (13) grazing intensity (GrzClass), (14) fire history or evidence (BrnClass), (15) mean annual precipitation (precip), and (16) mean annual summer drought length (drought); and additionally (17) largest tree.

Although not directly an environmental variable, the date at the beginning of each type of animal survey for each plot also was recorded. Measurements of vegetation structure and other site factors were taken on the bird-survey date, but the presence or absence of plant species was determined by several visits as discussed below in the section on species.

Dominant tree and basal area--The dominant tree species (either pine or post oak) was determined from the basal area and was categorical (if pine then Pine1 = 1, if post oak then Pine1 = 0). The other 3 associated factors (P_BA, K_BA, and all_BA) are the actual basal area measurements, respectively, for pine, post oak, and all tree species combined.

The method used to estimate tree basal area was a modification of the transect methods of Avery and Burkhart (1983) and Husch et al. (1993). Following the path of the 3 primary rays, 3 transects were selected. Each transect began 3 m from the plot center-point and continued away from there for

55.75 m. Each transect was 4-m wide. The area contained in the 3 transects combined was 0.067 ha.

While pulling a measuring tape from the transect beginning, a lightweight rod was carried which when held outstretched in the hand reached 2 m from sternum to rod tip. Any tree for which the center could be reached while straddling the transect centerline (i.e., was at least half in the transect), and that was >25-cm diameter breast-high, was measured for diameter and recorded. Trees <25-cm diameter were not included in the basal area calculations or in the estimate of basal area. Any tree questionably in or out of a transect was checked for distance from the centerline with a measuring tape. For each qualifying tree the diameter was measured parallel to the transect with a shop-made caliper. Any tree questionably more or less than 25 cm was checked with the caliper.

Subsoil texture--The categorical factor Sand1 is determined from the particle size distribution (PSD) of the subsoil (if percent sand equal to or >70% then Sand1 = 1, otherwise = 0 [i.e., clay + silt >30%]). The combination of clay plus silt is commonly called *fines* by soil scientists. The other 3 associated factors (pcSand, pcSilt, and pcClay) are the actual percentages of sand, silt, and clay, respectively.

Particle size distribution (percent sand, silt, and clay) was determined in the lab by the pipette method of Kilmer and Alexander (1949). For each plot the subsoil was obtained using a person-powered posthole digger. On each of the 3 primary rays a hole, 35-cm deep, was dug approximately 40 m from the plot center, with the constraint that the location not be an obvious soil anomaly relative to the overall plot (e.g., small, ephemerally wet depression). If it was an anomaly the location was moved a few meters to soil not an obvious anomaly.

From each clean hole a slice of uniform width and thickness was taken from the 25–35-cm depth (i.e., the slice was 10-cm long). The 3 slices were combined and mixed in a clean bucket and stored in a clear freezer bag. An identifying label in both pencil and indelible ink was placed in the bag and the bag sealed. The bag also was labeled outside with indelible ink.

Visibility and understory density--A white cloth was attached to the back of the neck and shoulder area (center 1.5-m height) and another cloth encircled the right leg above the knee (center 0.5-m height). The vertical dimension of each cloth was 25 cm. The width of the neck and shoulder cloth was 40 cm.

On each of the 3 secondary rays a point was located 35 m from the plot center-point. If that point was inside a bush or tree, the point was located immediately adjacent to that bush or tree. At each point a random bearing was chosen and 2 other bearings at 120º angles. A person was seated at the first point and maintained an eye level of 1-m height. The person wearing the white cloths walked straight away on the first bearing while dragging a measuring tape. The seated observer halted the walker immediately when a cloth was completely obscured and the tape was pulled tight and the distance recorded as either neck level (1.5 m) or knee level (0.5 m), whichever was the case. Then the walker continued until the other cloth was obscured and that distance recorded.

The process was repeated at the other 2 points for a total of 9 bearings and 18 distances recorded (9 neck, 9 knee). The data for the 2 heights were kept separate. The mean visibility at neck level was 1 index of understory density (VisNeck) and the mean visibility at knee level was another index (VisKnee).

Ground cover--This factor (GrndCov) generally referred to the herbaceous vegetation below 0.5 m but included some sprawling woody plants. A scale of 0–3 was used to measure ground cover by ocular estimate and referred to the mean density or cover for the entire 1-ha plot ignoring patchiness. Zero indicated no or sparse ground cover of generally no more than 1 small or slender herbaceous plant per several square meters, but the ground was usually covered with dead tree leaves. A 1 indicated the ground cover shaded approximately 1–5% of the surface if hypothetically exposed to full sun at midday (the term shade refers to the percent actually shaded and does not refer to the drip line). Two indicated 6–25% shading. Three indicated 26–60% shading. Three generally referred to a more or less continuous stand of grass or grass-like plants but the individual plants were not dense and dead tree leaves could still be seen through the plants. There were no plots with mean ground cover >60%.

Opening presence--This factor (opening) referred to a natural opening as defined in an earlier section on plot selection. If an opening was present the factor level was 1. If an opening was not present the factor level was zero.

Grazing intensity--This factor (GrzClass) referred to the obvious effects of grazing by cattle (the only domestic livestock occurring in any of the plots). Measurement of the factor was by ocular estimate on a scale of 0–3 and was highly subjective. Signs of cattle grazing include: (1) trails, tracks, and droppings, (2) the total removal of the upper part of individual grass clumps, (3) the shape of shrubs above the reach of any other grazing mammals occurring in the plots, and (4) the absence of plants preferred by cattle but expected in a plot, or the presence of plants preferred by cattle and usually removed promptly by cattle grazing. The relative intensity (levels) of this factor applied only to this study and not necessarily elsewhere but can be put in context. Many of the plots were not grazed and the level was zero. There were no severely grazed plots. The level 3 indicates heavy but not severe grazing.

Fire history or evidence--This factor (BrnClass) referred to the obvious effects of fire. Measurement of the factor was by ocular estimate on a scale of 0–3 and was highly subjective. Signs of fire include blackened ground and/or tree trunks, often in conjunction with standing damaged or dead vegetation. The relative levels of this factor applied only to this study and not necessarily elsewhere. Levels were meant to indicate the effect of fire on current vegetation and attempted to measure the confounded effects of fire intensity and length of time since burned.

Many of the plots showed no evidence of fire, past or present, and the level was zero. Level 1 indicated a mild burn in the distant past and was generally characterized by sparse and low (<15-cm high) blackening of tree trunks, no blackening of ground, and no standing dead vegetation with blackening anywhere. Level 2 generally indicated 10–50% blackened trees with blackening 16–200-cm high, but no standing dead vegetation with blackening anywhere and no blackening of ground. Level 3 indicated 10–50% blackened trees with blackening 16–200-cm high, with blackening of ground and standing dead vegetation, with an open understory, but with patches of unburned or regrowth understory (i.e., entered into the next growing season since the fire). There were no plots with fire more severe and more recent than level 3 because these would not have met the criteria for plot inclusion. In any case, none were in the random sampling.

Mean annual precipitation--For each plot precipitation (precip) was determined by interpolating the isolines of a precipitation map of Texas (Bureau of Business Research 1976)

Mean summer drought length--For each plot drought length (drought) was determined by interpolating the isolines of a drought-length map of Texas (Bureau of Business Research 1976)

Largest tree --To provide perspective concerning the age of the forest stand within a given plot, the largest tree was located (not necessarily on a basal area transect). The species of the largest tree was recorded and its diameter breast-high was measured and recorded.

Date--Starting dates for each type of animal survey for each plot were recorded (Table 1). The dates also were converted for use as covariables. Annually the first day for the start of the vertebrate surveys was 22 March. That date was assigned the value 1 and all other days follow from that day, irrespective of year. The covariable *HerpDay* was considered for use with species groups collected by the herp-array method. The earliest herp array began on 22 March, so the lowest value for HerpDay was 1. The earliest bird survey began 44 days later so the lowest value for the covariable *BirdDay* was 45. BirdDay was considered for use with the bird group.

The field surveys took place during the years 1996–2002 inclusive. Year was assumed to be irrelevant when evaluating many different species in large groups over a few years. The main concern was the potential change in the abundance or delectability of some groups of animal species as the season(s) progressed. However, all plant and animal surveys for the year 1996 were repeated in either 1999 or 2000. Only minor differences were found so the original 1996 surveys were used in the analysis.

Species

For each plot the presence or absence of species in a species group was determined (indicated) by the survey method used for the group . The same 2 observers (myself and an assistant) simultaneously and in close cooperation conducted all the survey procedures. Nine groups of species were surveyed and recorded separately, but subsequently herptiles and small mammals were grouped together for analysis (i.e., as small, primarily ground-dwelling vertebrates). Two groups (forbs, and grasses), were not used herein. Thus, 6 groups were used in the analysis: (1) woody plants (woody), (2) birds, (3) herptiles and small mammals (MamHerp), (4) beetles, (5) ants + velvet ants (ants), and (6) spiders.

Plants--To determine the species of plants occurring in the plots, for each of 2 years (not necessarily consecutive) each plot was visited at least 3 times with at least 1 visit in each of 3 time periods: 1 March–30 April; 1 May–15 July; 16 July–31 October. The plot was walked in concentric circles from the center. The circles were 5-m apart, more or less, depending on understory density and the minimum distance needed to ensure complete coverage.

Most woody plants species were well known and identified in the field, but voucher specimens of each woody species were collected from a few plots and verified in the lab. Plant specimens were deposited at one of the following herbariums depending on where they were identified: (1) Biology Department Herbarium, Texas A&M University, or (2) Tracy Herbarium, Texas A&M University.

Birds--The concept of optimization to meet the objective (Verner 1988) was the guide in developing the bird survey technique (and other techniques). Birds were surveyed during the period 7 May–6 July (49 of the 60 surveys were conducted within the period 22 May–30 Jun, inclusive). Birds were not surveyed on days when rain or wind interfered with hearing and or the activity of birds. Prior to the study the observers practiced estimating distance to various bird species in the various plot vegetation types by separating and observing birds vocalizing and then measuring the distance to the separated partner who could not see the bird.

The observers arrived at the plot to be surveyed 1–2 hours before noon. Usually a plant survey was conducted for several hours, all the while listening and becoming familiar with the birds in or near the plot (i.e., a pre-survey period for birds). The combined observers had approximately 50 years of experience identifying bird vocalizations in the area, but during the pre-survey period, birds heard that were of questionable identity were immediately compared with reference tapes provided by the Center for Bioacoustics at Texas A&M University, Corpus Christi, Texas. None of the birds heard during this pre-survey period were listed as being in the plot.

The survey was done in 2 periods. The first period began at 1.5 hours before sundown and ended at 2.5 hours after sundown. After the first survey period the observers generally retired to a tent a few hundred meters from the plot. The second survey period began the next morning at 1.5 hours before sunrise and ended 2.5 hours after sunrise.

The procedures were the same for both periods. The observers were seated at the center of the plot wearing dull brown or green clothing. The observers logged any bird species vocalizing within an estimated 56.4-m radius of the center (1 ha). Birds seen but not heard were not logged (a rare situation). Woodpeckers (*Picidae*) were logged if seen as a result of pecking noise. There was no effort to elicit vocalizations by playing a tape or otherwise.

During the survey a sensitive microphone (AKG D230 Austria CE) and battery-powered recorder (Marantz PMD 222) also were used to provide a record. The microphone was suspended from a limb or on a stake a few meters behind the observers (if the microphone was not placed behind the observers at some distance the recordings would be dominated by the faint whispers between observers). The tapes were 90-minutes long and were quickly replaced as needed so the recording was continuous.

The recorder had a timer. If and when a questionable bird vocalization was heard, the number on the timer was noted for later reference. Immediately after each period the recordings were replayed as needed to compare with tapes of known bird vocalizations played on a second recorder. In rare cases a tape was sent to Robert Benson at the Center for Bioacoustics, Texas A&M University for a second opinion. For most plots there was no need to refer to the recordings, but in a few cases they were a valuable asset.

Small mammals--The survey period for small mammals was 22 March–11 November, inclusive. Two methods were used to survey small mammals. One method used Sherman box traps in a circular array as modified from Jones et al. (1996). The array consisted of 3 concentric circles at 15, 30, and 45 m from the plot center-point. Traps were spaced approximately 8.5 m apart for 11, 22, and 33 traps in the circles, respectively (66 traps). The Sherman live traps were aluminum and the dimensions were 7.6 X 8.9 X 22.9 cm. One additional larger aluminum trap (10.2 X 11.4 X 38.0 cm) was located subjectively in the plot near cover (downed hollow trees and vine tangles) often used by the Florida wood rat (*Neotoma floridana*).

Traps were placed in the circular array by hanging an orange marker at the plot center-point, measuring the proper distance to a concentric circle, and maintaining that distance while pacing the circle and setting the traps at the 8.5-m intervals. Traps were placed under low vegetation cover if available within 1 m of the paced point. The wood-rat trap was placed on the second trap day (i.e., after noting potential places while setting the smaller traps, and while checking the smaller traps on the second day). All traps were baited with a rolled ball of mixed un-pasteurized peanut butter and uncooked oatmeal.

Traps were checked by midmorning each day. The smaller traps were in place and set for 3 nights. The wood rat trap was in place and set for 2 nights. All species caught could potentially be caught in any of the traps, and wood rats were caught in the smaller traps. There were 200 trap nights per plot (66 X 3 + 1 X 2).

No trapping was done by this box trap method from mid-July through the end of August because of extreme heat and high fire ant (*Solenopsis invicta*) densities and activity. A small mammal species was considered present in a plot if an individual of that species was captured in that plot by either the Sherman traps or in a herp array (discussed below).

Identification of small mammals followed Schmidly (1983), names followed Whitaker (1996). If necessary for identification, small mammals were immobilized by briefly placing the mammal in a closed bucket containing a cotton ball partially soaked with halothane. Any measurements needed were then made quickly and the mammal released. Some specimens had to be euthanized with halothane and taken to the TCWC to compare with reference specimens and or be identified by mammalogist Duane Schlitter. These were then placed in the TCWC.

Herptiles and herp array construction--The method used for surveying herptiles was the herp array as modified from Corn (1994). The herp array consisted of a center pitfall trap, 3 drift fences radiating from the pitfall at 120º angles, and a funnel trap on each side of the distal end (away from the center bucket) of each drift fence.

The pitfall trap was a 22.7-L bucket. The opening of the bucket was 29-cm wide. The depth of the bucket was 36 cm. The bucket was buried in the ground but extended 3–4 cm above the ground to help prevent filling with runoff water during rains. Soil was mounded gradually to the bucket lip.

The drift fence was aluminum flashing 50.8-cm high. The effective length of each of the 3 drift fences was 5 m. The drift fences were buried 3–5 cm in the ground and held vertical by wooden stakes 2-cm thick and shorter than the drift fence. The stakes were placed first in pairs tight together and 1–2 m apart, then the flashing was slipped in between the stakes. Three 5–6-cm vertical slits were cut in the bucket with a hacksaw so the flashing could project 1–2 cm into the bucket.

The funnels traps were constructed of eighth-inch hardware cloth (10.1-mm^2 openings). The traps had 2 compartments (cylinders) each 15 cm in diameter and either 45.7- or 61.0-cm long (depending on available hardware cloth width at time of construction). Each compartment was constructed by rolling a 50-cm-long piece into a slightly overlapping cylinder and temporarily securing with staples. Funnels were constructed in a similar way by rolling 1 end nearly shut and the other end more open (cone shaped) and adjusting the cone shape so about half of the funnel would fit tightly into a cylinder (i.e., the outside part of the funnel was much wider than the cylinder). The funnel shape was temporarily held by staples and the minimum funnel opening set slightly smaller than the final desired diameter. Three funnels were constructed per funnel trap.

The cylinders were placed in line and a funnel placed between them and at each end, all in the same direction, and secured with staples. Then the seams of the cylinders and the funnels and all connections were caulked with a construction adhesive (polyurethane). The following day, after the adhesive had set, the distal funnel was rolled shut, stapled shut, and permanently caulked shut to form a dead end. The outer flare of the funnels was intentionally much wider than the cylinders. These were trimmed off of the distal and middle funnels, but not off of the first (entering) funnel because the flare was used to increase the effective funnel width.

Prior to caulking the cylinders, a door 15-cm wide and 20-cm long was cut out following the seam of the cylinders, which would be facing up when the herp array was in operation. A slightly larger piece of hardware cloth was used to cover these holes and the piece permanently secured with staples at 1 end parallel to the cylinder and then caulked at that same end. In this way the other end of the door could be lifted open as far as needed to remove specimens caught or to clean the trap. When in use the door was held shut tightly with baling wire encircling the cylinder.

Prior to use the small funnel openings were set at 4.5 cm in diameter for the first funnel and 3.5 cm for the internal funnel by using smooth hoe handles of those dimensions and forcing the openings to the desired diameters. Because of the 1-way double funnel construction, the trap was escape proof. Animals entering the trap promptly followed the flow of the funnels into the second compartment. Animals occasionally escaping into the first compartment immediately followed the funnel flow back into the second compartment.

Herptiles and herp array operation--The survey period for herptiles was 22 March–11 November, inclusive. Each array was in operation for 10 consecutive nights. Herp arrays were not used during July and August because of the potential detrimental effects of high temperature and low humidity on amphibians, and because of high fire ant densities and activity.

For each plot only 1 array was used, and only for 1 10-night period. The center of the array (the pitfall trap) was subjectively placed within 5 m of the plot center-point. The subjectivity was needed to orient the 3 drift fences (at 120º angles) so as to avoid any drift fence going through the middle of large trees. Prior to installation the path of each drift fence was raked for a width of 1 m so the soil was completely exposed and no objects were present that might turn a herptile away from the drift fence.

The funnel traps at the distal ends of the drift fences opened toward the center bucket, and were held tightly in place with wooden stakes to help prevent movement by large, curious predators. Soil was packed at the contact point of the funnel with the ground and with the drift fence to ensure no herptiles could pass under the funnel or between the funnel and the drift fence. Each drift fence was slightly longer than 5 m, but the funnel trap was placed so the distance from the array center to the funnel opening was 5 m. The drift fences did not extend beyond the funnel traps. A gray towel was placed over the second compartment of each funnel trap for shade. A 1-m^2 plywood board was balanced on the center junction of the 3 drift fences to shade the pitfall trap. A wet sponge was placed in the bucket in dry weather and a dry sponge in wet weather.

Trapped herptiles and small mammals were removed from the funnel traps through the top door, using leather gloves if needed, and then securing the door again with a twist of the encircling baling wire. Poisonous snakes (*Elapidae*, *Crotalinae*) were removed by lifting the trap, opening the door, dumping the snake, and replacing the trap within the undisturbed holding stakes.

Identification and names of herptiles followed Conant and Collins (1998). A few specimens required a hand lens and reference to details (e.g., scale pattern). These specimens were restrained by hand and then released. No herptiles were euthanized. The many small mammals captured in the herp arrays were handled as discussed earlier above in the section on small mammals.

Beetles, ants plus velvet ants, and spiders--Many invertebrates were captured in the pitfalls of the herp arrays. Selected groups were collected by picking individuals from the pitfalls using tweezers designed for handling invertebrates without crushing them. The pitfalls (buckets) were all completely white, which facilitated seeing and collecting invertebrates. The collected invertebrates were placed in jars of 70% ethanol along with the plot label in pencil and in indelible ink. The jars were re-sealable and the same jar for a given plot was used each time that plot (herp array) was visited unless a second or third jar was needed to handle the volume of invertebrates for that plot.

After each field season (i.e., in winter) my assistant and I rinsed the specimens, 1 plot at a time, with clean ethanol and sorted them into 3 selected groups (beetles, ants plus velvet ants, and spiders). The different groups were placed in separate jars of 70% ethanol and the plot label included in each jar. Later I separated the spiders into families. At all times the link between a specimen and the plot from which it came was maintained.

Beetles were identified to species by Edward G. Riley, Department of

Entomology, Texas A&M University. Ants were identified to species by Bill Summerlin, Department of Entomology, Texas A&M University. Velvet ants were identified to species by Donald G. Manley, Pee Dee Research and Education Center, Clemson University. Spiders were identified to species by Allen Dean, Department of Entomology, Texas A&M University

Analysis

Three types of analyses were done: (1) similarity indices, (2) logistic regression, and (3) canonical correspondence analysis (CCA) and or redundancy analysis (RDA).

Similarity indices--Three similarity indices were selected (Magurran 1988, Colwell 2004). These were: (1) Jaccard Classic, (2) Sorenson Classic, and (3) Morista-Horn. The value of each of these indices was computed using EstimateS© (Colwell 2004), (free at http://purl.oclc.org/estimates). Two different comparisons were made for each of the 6 species groups enumerated earlier. One comparison was between the 2 classes of the factor Pine1 (i.e., pine versus post oak). The other comparison was between the 2 classes of the factor Sand1 (i.e., sandy subsoils versus silt and or clay subsoils). All recorded species were used to compute the similarity indices, including species present in only 1 plot.

For perspective concerning the degree and meaning of similarity between the 2 vegetation classes investigated (pine and post oak), a comparison also was made by combining these 2 vegetation classes into 1 class (mature east

Texas upland forest within the study area) versus native south Texas upland shrubland within the Chaparral Wildlife Management Area (Chap). The Chap is in Dimmit and La Salle counties and is approximately 500 km southwest of the study area, at approximately the same elevation, with no major biogeographic barriers between. Some comparable environmental variables for the Chap include: (1) mean annual summer drought length 70 days, (2) mean annual evaporation rate 147 cm, (3) mean annual precipitation 54 cm, (4) mean annual temperature 22 °C (Bureau of Business Research 1976).

The Chap contains 6,151 ha and is owned and operated by TPWD. Data for the Chap were obtained with the permission of TPWD. Chap manager, David Synatzske, provided data on the presence by species of plants, birds, mammals, and herptiles. From this south Texas data subsets of data were extracted (Tables 3–5) that conformed to the same protocol as the east Texas forest study (i.e., for a given study area, only upland species apparently breeding in that study area were used). For each of the 3 comparable species groups (woody plants, birds, and mammals plus herptiles) similarity indices were computed to compare the south Texas upland shrubland with the east Texas upland forest as represented by the respective areas inventoried.

Logistic regression--Unlike the similarity indices, for logistic regression only species were used that occurred in >4 plots and <56 plots. For each of the 6 species groups a separate set of logistic regressions was run for each species using the LOGISTIC procedure of SAS® (SAS Institute Inc. 2001). For

Table 3. Chaparral Wildlife Management Area[a] woody plant species. (a subset of data provided on 13 September 2004 by Area Manager David Synatzske and printed herein with permission of the Texas Parks and Wildlife Department).

Scientific name	Common name
Acacia angustissima	Acacia
Acacia berlandieri	Guajillo
Acacia greggii	Catclaw
Acacia minuata	Huisache
Acacia rigidula	Blackbrush
Acacia roemeriana	Roemer acacia
Acacia schaffneri	Twisted acacia
Aloysia gratissima	Whitebrush
Baccharis neglecta	Roosevelt weed
Celtis laevigata	Sugar hackberry
Celtis pallida	Spiny hackberry (Granjeno)
Colubrina texensis	Hogplum
Condalia hookeri	Brasil
Condalia spathulata	Knifeleaf condalia
Diospyros texana	Texas persimmon
Ephedra antisyphilitica	Vine ephedra
Forestiera angustifolia	Narrowleaf forestiera
Guajacum angustifolium	Guayacan
Karwinskia humboldtiana	Coyotillo
Koeberlinia spinosa	Allthorn
Lantana achyranthifolia	Veinyleaf latana
Lantana urticoides	Common latana
Leucophyllum frutescens	Ceniza
Lycium berlandieri	Wolfberry
Opuntia engelmannii	Texas prickly pear
Opuntia leptocaulis	Pencil cholla
Parkinsonia aculeata	Retama
Parkinsonia texana	Texas paloverde
Populus deltoides	Eastern cottonwood
Prosopis glandulosa	Honey mesquite
Quercus virginiana	Live oak
Rhus microphylla	Littleleaf sumac

Table 3. Continued.

Scientific name	Common name
Salix nigra	Black willow
Salvia ballotiflora	Shrubby blue sage
Sapindus saponaria	Western soapberry
Sideroxylon celastrina	Coma
Sideroxylon lanuginosum	Woollybucket bumelia
Sophora secundiflora	Mescalbean
Ulmus crassifolia	Cedar elm
Zanthoxylum fagara	Lime pricklyash
Zizyphus obtusifolia	Lotebush
Zizyphus zizyphus	Jujube

[a] The Chaparral Wildlife Management Area (Chap) is in Dimmit and La Salle counties in south Texas.

Table 4. Chaparral Wildlife Management Area[a] upland breeding bird species (subset of data provided on 13 September 2004 by Area Manager David Synatzske and printed herein with permission of the Texas Parks and Wildlife Department).

Scientific name	Common name
Accipter cooperii	Cooper's hawk
Agelaius phoeniceus	Red-winged blackbird
Aimophila cassinii	Cassin's sparrow
Amphispiza bilineata	Black-throated sparrow
Arremonops rufivirgatus	Olive sparrow
Athene cunicularia	Burrowing owl
Ayriparus flaviceps	Verdin
Baeolophus atricristatus	Black-crested titmouse
Bubo virginianus	Great horned owl
Buteo jamaicensis	Red-tailed hawk
Callipepla squamata	Scaled quail
Campylorhynchus brunneicapillus	Cactus wren
Caracara cheriway	Crested caracara
Cardinalis cardinalis	Northern cardinal
Cardinalis sinuatus	Pyrrhuloxia
Carpodacus mexicanus	House finch
Carthartes aura	Turkey vulture
Charadrius vociferus	Killdeer
Chondestes grammacus	Lark sparrow
Chordeiles acutipennis	Lesser nighthawk
Chordeiles minor	Common nighthawk
Coccyzus americanus	Yellow-billed cuckoo
Colinus virginianus	Northern bobwhite
Columbina inca	Inca Dove
Columbina passerina	Common ground-dove
Coragyps atratus	Black vulture
Corvus cryptoleucus	Chihuahuan raven
Crotophaga sulcirostris	Groove-billed ani
Cyanocorax yncas	Green jay
Elanus leucurus	White-tailed kite
Geococcyx californianus	Greater roadrunner
Hirundo rustica	Barn swallow
Icterus bullockii	Bullock's oriole

Table 4. Continued

Scientific name	Common name
Icterus cucullatus	Hooded oriole
Icterus graduacauda	Audubon's oriole
Icterus spurius	Orchard oriole
Leptotila verreauxi	White-tipped dove
Megascops asio	Eastern screech-owl
Melanerpes aurifrons	Golden-fronted woodpecker
Meleagris gallopavo	Wild turkey
Mimus polyglottos	Northern mockingbird
Molothrus aeneus	Bronzed cowbird
Molothrus ater	Brown-headed cowbird
Myiarchus cinerascens	Ash-throated flycatcher
Myiarchus tyrannulus	Brown-crested flycatcher
Nyctidromus albicollis	Common pauraque
Parabuteo unicinctus	Harris's hawk
Passerina caerulea	Blue grosbeak
Passerina ciris	Painted bunting
Passerina cyanea	Indigo bunting
Phalaenoptilus nuttallii	Common poorwill
Picoides scalaris	Ladder-backed woodpecker
Polioptila melanura	Black-tailed gnatcatcher
Pyrocephalus rubinus	Vermilion flycatcher
Quiscalus mexicanus	Great-tailed grackle
Spiza americana	Dickcissel
Thryomanes bewickii	Bewick's wren
Toxostoma curviostre	Curve-billed thrasher
Toxostoma longirostre	Long-billed thrasher
Tyrannus forficatus	Scissor-tailed flycatcher
Tyrannus tyrannus	Eastern kingbird
Tyrannus verticalus	Western kingbird
Tyto alba	Barn owl
Vireo bellii	Bell's vireo
Vireo griseus	White-eyed vireo
Zenaida asiatica	White-winged dove
Zenaida macroura	Mourning dove

[a] The Chaparral Wildlife Management Area (Chap) is in Dimmit and La Salle counties in south Texas.

Table 5. Chaparral Wildlife Management Area[a] upland herptile and small mammal species (a subset of data provided on 13 September 2004 by Area Manager David Synatzske and printed herein with permission of the Texas Parks and Wildlife Department).

Scientific name	Common name
Baiomys taylori	Northern pygmy mouse
Chaetodipus hispidus	Hispid pocket mouse
Dipodomys ordii	Ord's kangaroo rat
Mus musculus	House mouse
Neotoma micropus	Southern plains woodrat
Notiosorex crawfordi	Desert shrew
Onychomys leucogaster	Northern grasshopper mouse
Perognathus merriami	Merriam's pocket mouse
Peromyscus leucopus	White-footed mouse
Reithrodontomys fulvescens	Fulvus harvest mouse
Sigmodon hispidus	Hispid cotton rat
Spermophilus mexicanus	Mexican ground squirrel
Acris crepitans	Northern cricket frog
Arizona elegans	Eastern glossy snake
Bufo debilis	Green toad
Bufo speciosus	Texas toad
Bufo valliceps	Gulf coast toad
Cnemidophorus gularis	Texas spotted whiptail
Cnemidophorus sexlineatus	Racerunner
Coleonyx brevis	Texas banded gecko
Crotaphytus reticulatus	Reticulate collared lizard
Drymarchon corais	Western indigo snake
Elaphe guttata	Great plains rat snake
Eumeces obsoletus	Great plains skink
Eumeces tetragrammus	Four-lined skink
Gastrophryne olivacea	Great plains narrowmouth toad
Heterodon nasicus	Western hognose snake
Holbrookia lacerata	Spot-tailed earless lizard
Holbrookia propinqua	Keeled earless lizard
Hypsiglena torquata	Night snake
Lampropeltis getula	Speckled kingsnake
Lampropeltis triangulum	Milk snake

Table 5. Continued

Scientific name	Common name
Masticophus flagellum	Coachwhip
Masticophus schottii	Schott's whipsnake
Nerodia rhombifer	Diamondback water snake
Phrynosoma cornutum	Texas horned lizard
Pituophis catenifer	Gopher snake
Pseudacris clarkii	Spotted chorus frog
Rana berlandieri	Rio Grande leopard frog
Rana catesbeiana	Bullfrog
Rhinocheilus lecontei	Longnose snake
Salvadora grahamiae	Mountain patchnose snake
Scaphiopus couchii	Couch's spadefoot
Sceloporus olivaceus	Texas spiny lizard
Sceloporus undulatus	Fence lizard
Sceloporus variabilis	Rosebelly lizard
Sonora semiannulata	Ground snake
Tantilla gracilis	Flathead snake
Tantilla nigriceps	Plains blackhead snake
Thamnophis marcianus	Checkered garter snake
Thamnophis proximus	Western ribbon snake

[a] The Chaparral Wildlife Management Area (Chap) is in Dimmit and La Salle counties in south Texas.

each regression the given species was the dependent variable (i.e., present = 1 and absent = 0, as determined for each of the 60 plots). Dominant tree species (Pine1) and subsoil texture (Sand1), each with dichotomous classes, were the explanatory factors. For each given species 3 logistic regressions were run with the explanatory factors: 1 with Pine1 only; 1 with Sand1 only; and 1 with both plus the interaction term.

As an aid to interpretation the data can be conceptualized as a contingency table. The factors dominant tree and subsoil texture each had 2 levels, making a 2 X 2 contingency table. There were 60 plots and because the design was balanced there were 15 plots associated with each cell. A given species either occurred in a plot or it did not. Consequently, for a given species the presence (not the abundance) was from 0–15 in each cell, and from 0–30 for each factor.

Procedures other than logistic regression could have been used to analyze the contingency tables, but the logistic regression procedure was chosen for 3 reasons: (1) the availability of the events/trials syntax (e.g., 3 15 meaning 3 present/15 plots) that made it easy to enter data compiled with a spreadsheet, (2) the exact option that allowed the computation of the Chi-squared statistic when cell counts were low or zero, and (3) the ease of checking for interaction of the factors.

Each logistic regression reported the Chi-squared statistic and probability as a measure of the strength of the association between a given species and a given factor (either dominant tree or subsoil texture). For that given species the factor with the strongest association (smallest probability) was noted, and interactions between the factors were noted if any. Also, the difference between the probabilities for the 2 factors for that species was recorded for reasons below.

For each species group the number of species that had a distribution most associated with dominant tree species was determined by inspection (counted). Likewise the species that had distributions most associated with subsoil texture were counted. To determine if 1 factor or the other was statistically most often associated with a given group of species, the Wilcoxon Signed Rank test was used as implemented by the UNIVARIATE procedure of SAS. The difference between the probabilities for the 2 factors for each species can be described as a column of differences with usually some positive and some negative. The order of subtraction is not important but must be constant (e.g., dominant probability – soil probability). The Wilcoxon Signed Rank test assumes the distribution of differences is symmetrical. This assumption was examined by the Shapiro-Wilk test of the UNIVARIATE procedure of SAS. This test is for normality, but if normality is not rejected the distribution is symmetrical. If normality was rejected the Wilcoxon Sign test was used as implemented by the UNIVARIATE procedure of SAS.

For each species the best model was determined based on the Akaike criterion of the LOGISTIC procedure of SAS. The coefficient of determination

(R^2) also was determined by the LOGISTIC procedure of SAS.

CCA and RDA--Only species that occurred in >4 plots were used for CCA or RDA. Computations were made using CANOCO (ter Braak and Smilauer 2002). Understanding and interpretation were further enhanced by supplementary information from Jongman et al. (1995), and Leps and Smilauer (2003). The decision to use CCA versus RDA was made for each species group based on criteria suggested by Leps and Smilauer (2003:50-51). For this study either method produced results that differed little and conclusions were the same, but RDA was used in the final analysis. A measure of the strength of the association of a factor with the distribution of a species was provided by CANOCO as a probability based on a Monte Carlo permutation test.

Both CCA and RDA were conducted separately for each of the 6 species groups enumerated earlier. For some groups the date of collection was significant. To remove the effect of date (i.e., changing seasons) the covariable HerpDay was used with MamHerp, ants, beetles, and spiders. The covariable BirdDay was used with birds.

For each group the first 16 factors enumerated earlier were entered (with covariable if appropriate) and the factor having the strongest association determined for each group. Subsequently the factors were evaluated using CANOCO to determine their inter-correlations. As suggested by Leps and Smilauer (2003:54), factors strongly inter-correlated (either negatively or positively) were removed. All factors were tested in pairs and 1 of a highly correlated pair removed until no highly correlated pairs remained. The decision of which factor of a correlated pair to keep was based on the need to keep the factors most relevant to the objective (i.e. dominant tree and soil) . The factors P_BA, K_BA, pcSand, pcClay, VisKnee, precip, and drought were removed. The remaining analyses were done with the 9 factors: Pine1, Sand1, all_BA, pcSilt, VisNeck, GrndCov, opening, GrzClass, and BrnClass.

Using the automated forward selection procedure of CANOCO, the 4 most strongly associated factors were selected for each of the 6 species groups (not necessarily the same 4 factors for different groups). The cumulative percent of the variance explained based on the eigenvalues was determined. The association of species, factors, and plots was graphically indicated by the CANOCO companion graphics program CanoDraw for Windows (ter Braak and Smilauer 2002).

In addition to CCA and RDA, the principal components analysis (PCA) of CANOCO also was conducted on the same data sets to determine how much of the variance of the distribution of species within each group actually could be explained, and to determine the effect and need for the covariables if any.

RESULTS

Similarity Indices

For each species group (Appendices A–F) the EstimateS program (Colwell 2004) reported (Table 6): (1) the number of species observed and (2) the paired comparisons for the 2 classifiers investigated (dominant tree and subsoil texture). For dominant tree the number of species in each of the 2 classes (pine and post oak) was given and also the number in common. For soil texture the number of species in each of the 2 classes (sand and not sand) was given and also the number in common. The similarity indices also were reported. The same type of information above also was reported (Table 7) for the classes East Texas and South Texas as defined earlier.

Within east Texas, 550 species were used in the similarity indices over all groups, and 266 of these species (48.4 %) were in common with both pine and post oak forest. For all of the comparisons the focus was on the similarity indices. Each index is computed differently. Comparisons should be made only within the same index. All of the indices were consistent and supported the same conclusion within each group. For 5 of the 6 east Texas species groups, the classifier dominant tree provided greater separation than soil texture. Within a group the index value for any given similarity index differed little between a classification based on dominant tree and a classification based on subsoil texture.

Table 6. Paired comparisons of similarity within species groups separated into 2 subclasses: (1) dominant tree[a], and (2) soil texture[b]. Data obtained on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

Group	Total species observed	Classifiers to compare	Subclass, and total species in subclass	Species in common	Similarity[c] Jaccard Classic	Sorenson Classic	Morista-Horn
Ant+Velvet ant (*Hymenoptera*)	53	Dominant tree	Pine = 42 PostOak = 39	28	0.53	0.69	0.83
Ant+Velvet ant (*Hymenoptera*)	53	Subsoil texture	Sand = 47 Clay+Silt = 32	26	0.49	0.66	0.81
Beetles (*Coleoptera*)	192	Dominant tree	Pine = 135 PostOak = 122	65	0.34	0.51	0.55
Beetles (*Coleoptera*)	192	Subsoil texture	Sand = 130 Clay+Silt = 132	70	0.36	0.53	0.67
Birds (*Aves*)	48	Dominant tree	Pine = 40 PostOak = 35	27	0.56	0.72	0.85
Birds (*Aves*)	48	Subsoil texture	Sand = 40 Clay+Silt = 41	33	0.69	0.81	0.97
Herps and small Mammals (*Reptilia, Amphibia, Mammalia*)	49	Dominant tree	Pine = 40 PostOak = 39	30	0.61	0.76	0.80
Herps and small Mammals (*Reptilia, Amphibia, Mammalia*)	49	Subsoil texture	Sand = 43 Clay+Silt = 38	32	0.65	0.79	0.87

Table 6. Continued.

Group	Total species observed	Classifiers to compare	Subclass, and total species in subclass	Species in common	Jaccard Classic	Sorenson Classic	Morista-Horn
Spiders (*Araneae*)	94	Dominant tree	Pine = 81 PostOak = 60	47	0.50	0.67	0.85
Spiders (*Araneae*)	94	Subsoil texture	Sand = 78 Clay+Silt = 66	50	0.53	0.69	0.87
Woody plant species (*Dicotyledonae*)	114	Dominant tree	Pine = 107 PostOak = 76	69	0.61	0.75	0.87
Woody plant species (*Dicotyledonae*)	114	Subsoil texture	Sand = 101 Clay+Silt = 89	76	0.67	0.80	0.87

[a] Dominant tree herein classifies 2 formation subclasses (UNESCO 1973), i.e. evergreen forest (pine) and deciduous forest (post oak).

[b] Subsoil texture herein classifies 2 subclasses: (1) the subclass Sand is = to or >70 % sand and <9% clay; and (2) the subclass Clay+Silt is <70% sand and = to or >9% clay.

[c] Similarity indices are each calculated differently and should be compared only within columns (e.g. for ant+velvet ant each of the 3 indices indicates subsoil texture provides a slightly better separation [i.e. less similar, more dissimilar]).

Table 7. Comparisons of similarity within species groups separated into 2 classes based on vegetation formations[a] within 2 study areas: 1 in south Texas[b] and 1 in east Texas[c].

Group	Total species observed	Classifier	Class, and total species in class	Species in common	Similarity: Jaccard Classic	Similarity: Sorenson Classic
Woody plant species (*Dicotyledonae*)	153	Vegetation Formations: Forest versus Shrubland	East Texas forest = 114 South Texas shrubland = 42	3	0.02	0.04
Herps+small Mammals (*Reptilia, Amphibia, Mammalia*)	84	Vegetation Formations: Forest versus Shrubland	East Texas forest = 49 South Texas shrubland = 51	16	0.19	0.32
Birds (*Aves*)	101	Vegetation Formations: Forest versus Shrubland	East Texas forest = 48 South Texas shrubland = 68	15	0.15	0.26

[a] As defined by UNESCO (1973).

[b] South Texas data provided on 13 September 2004 by David Synatzske, Area Manager, Chaparral Wildlife Management Area, Texas Parks & Wildlife Department. Printed here with permission of the Texas Parks & Wildlife Department.

[c] East Texas data collected on an upland forest study area during the period 1 March 1996 to 31 October 2002.

For the comparisons between east and south Texas 338 species were used, and only 34 of these species (10.1%) were in common with both areas. Each of the 3 species groups compared indicated the 2 areas differed greatly in species composition, and much more than the difference between the pine and post oak classes. For South Texas versus East Texas there were 153 woody species recorded with only 3 in common (2%). This contrasts with pine versus post oak where there were 114 woody species recorded and 69 of these were in common (61%).

Logistic Regression

For each species group (Tables 8–13) the LOGISTIC procedure of SAS reported the results of logistic regressions (Tables 14–19). For each species 3 regressions were summarized by the Chi-squared probability for the regression with: (1) dominant only, (2) soil only, and (3) dominant and soil and the interaction term. For the latter the Chi-squared probability shown was only for testing the interaction term. The factor most strongly associated with the distribution of a given species was indicated with a 1 in the appropriate column. The significance of the Wilcoxon Signed Rank test or the Wilcoxon Sign test was given and the conclusion stated.

For 4 of the species groups (ants, MamHerp, spiders, and woody) there was no significant ($P < 0.1$) difference between the factors (dominant or soil) and the strength of their association with the distribution of species as a group.

Table 8. Ant (*Formicidae*)[a] and velvet ant (*Mutillidae*)[b] names for species occurring in more than 4 of 60 plots on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

Reference[c] number	Scientific name	Common name[d]
01	*Aphaenogastor lamellidens*	(ant)
02	*Camponotus castaneus*	(ant)
03	*Camponotus ferrugineus*	(ant)
04	*Crematogaster ashmeadi*	(ant)
05	*Leptogenys elongata*	(ant)
06	*Pachycondyla harpax*	(ant)
07	*Solenopsis invicta*	Red imported fire ant
08	*Dasymutilla atrifimbriata*	(velvet ant)
09	*Dasymutilla mutata*	(velvet ant)
10	*Dasymutilla nigripes*	(velvet ant)
11	*Dasymutilla occidentalis*	(velvet ant)
12	*Dasymutilla quadriguttata*	(velvet ant)
13	*Dasymutilla vesta*	(velvet ant)
14	*Ephuta sudatrix*	(velvet ant)
15	*Myrmilloides grandiceps*	(velvet ant)
16	*Photomorphus* sp.	(velvet ant)
17	*Psuedomethoca frigida*	(velvet ant)
18	*Psuedomethoca sanbornii*	(velvet ant)
19	*Psuedomethoca simillima*	(velvet ant)
20	*Sphaeropthalma auripilis*	(velvet ant)
21	*Timulla floridensis*	(velvet ant)
22	*Timulla oajaca*	(velvet ant)
23	*Timulla wileyae*	(velvet ant)

[a] Formicidae were identified to species by Bill Summerlin, Entomology Department, Texas A&M University

[b] Mutillidae were identified to species by Donald G. Manley, Pee Dee Research and Education Center, Clemson University.

[c] The reference numbers apply to tables and figures interspersed in the text. The numbers do not apply to the full species lists in the appendices.

[d] There was only 1 accepted common name in this group.

Table 9. Beetle (*Coleoptera*) names for species occurring in more than 4 of 60 plots on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

Reference[a] number	Scientific name[b]	Common name[c]
01	*Agonum punctiforme*	(beetle)
02	*Alobates morio*	(beetle)
03	*Alobates pensylvanica*	(beetle)
04	*Amara* sp. 1	(beetle)
05	*Anisodactylus dulcicollis*	(beetle)
06	*Anisodactylus* sp. 1	(beetle)
07	*Blapstinus fortis*	(beetle)
08	*Brachinus* sp. 2	(beetle)
09	*Calathus opaculus*	(beetle)
10	*Calosoma scrutator*	(beetle)
11	*Calosoma wilcoxi*	(beetle)
12	*Canthon viridis*	(beetle)
13	*Conotrachelus posticatus*	(beetle)
14	*Cymindis limbatus*	(beetle)
15	*Dicaelus crenatus*	(beetle)
16	*Dicaelus furvus*	(beetle)
17	*Galerita bicolor*	(beetle)
18	*Gonwanocrypticus obsoletus*	(beetle)
19	*Helluomorphoides nigripennis*	(beetle)
20	*Helops cisteloides*	(beetle)
21	*Hylobius pales*	Pales weevil
22	*Lobopoda* sp. 1	(beetle)
23	*Lycoperdina ferruginea*	(beetle)
24	*Melanocanthon nigricornis*	(beetle)
25	*Merinus laevis*	(beetle)
26	*Necrophila americana*	(beetle)
27	*Nicrophorus orbicollis*	(beetle)
28	*Odontotaenius disjunctus*	Horned passalus
29	*Oiceoptoma inaequale*	(beetle)
30	*Omorgus monachus*	(beetle)
31	*Onthophagus tuberculifrons*	(beetle)
32	*Opatrinus minimus*	(beetle)

Table 9. Continued.

Reference[a] number	Scientific name[b]	Common name[c]
33	*Pachylobius picivorus*	Pitch-eating weevil
34	*Panagaeus fasciatus*	(beetle)
35	*Platydema micans*	(beetle)
36	*Platydracus* sp. 1	(beetle)
37	*Pterostichus premundus*	(beetle)
38	*Rhadine* sp. 1	(beetle)
39	*Scaphinotus elevatus*	(beetle)
40	*Scaphinotus liebecki*	(beetle)
41	*Selenophorus* sp. 1	(beetle)
42	*Sphenophorus bartramiae*	(beetle)
43	*Sphenophorus coesifrons*	(beetle)

[a] The reference numbers apply to tables and figures interspersed in the text. The numbers do not apply to the full species lists in the appendices.

[b] Beetles were verified to species by Edward G. Riley, Entomology Department, Texas A&M University.

[c] There were only 3 accepted common names in this group.

Table 10. Bird (*Aves*) common and scientific names[a] and species code[b] for species occurring in more than 4 of 60 plots on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

Reference[c] number	Scientific name	Common name	Code
01	*Passerina cyanea*	Indigo bunting	INBU
02	*Passerina ciris*	Painted bunting	PABU
03	*Cardinalis cardinalis*	Northern Cardinal	NOCA
04	*Icteria virens*	Yellow-breasted chat	YBCH
05	*Poecile carolinensis*	Carolina chickadee	CACH
06	*Caprimulgus carolinensis*	Chuck-will's-widow	CWWI
07	*Molothrus ater*	Brown-headed cowbird	BHCO
08	*Corvus brachyrhynchos*	American crow	AMCR
09	*Coccyzus americanus*	Yellow-billed cuckoo	YBCU
10	*Zenaida macroura*	Mourning dove	MODO
11	*Empidonax virescens*	Acadian flycatcher	ACFL
12	*Myiarchus crinitus*	Great crested flycatcher	GCFL
13	*Cyanocitta cristata*	Blue jay	BLJA
14	*Sitta carolinensis*	White-breasted nuthatch	WBNU
15	*Strix varia*	Barred owl	BAOW
16	*Megascops asio*	Eastern screech-owl	EASO
17	*Piranga rubra*	Summer tanager	SUTA
18	*Hylocichla mustelina*	Wood thrush	WOTH
19	*Baeolophus bicolor*	Tufted titmouse	(ETTI)
20	*Vireo olivaceus*	Red-eyed vireo	REVI
21	*Vireo griseus*	White-eyed vireo	WEVI
22	*Vireo flavifrons*	Yellow-throated vireo	YTVI
23	*Mniotilta varia*	Black-and-white warbler	BAWW
24	*Wilsonia citrina*	Hooded warbler	HOWA
25	*Oporornis formosus*	Kentucky warbler	KEWA
26	*Dendroica pinus*	Pine warbler	PIWA
27	*Picoides pubescens*	Downy woodpecker	DOWO
28	*Dryocopus pileatus*	Pileated woodpecker	PIWO
29	*Melanerpes carolinus*	Red-bellied woodpecker	RBWO
30	*Thryothorus ludovicianus*	Carolina wren	CARW

[a] Names follow the American Ornothologists' Union Check-list of North America Birds (2004 electronic).

[b] Species codes follow the North American Bird Banding Manual (USGS Patuxent Wildlife Research Center [2004 electronic])

[c] The reference numbers apply to tables and figures interspersed in the text. The numbers do not apply to the full species lists in the appendices.

Table 11. Small mammal (*Mammalia*)[a] and herptile (*Amphibia*, *Reptilia*)[b] names for species occurring in more than 4 of 60 plots on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

Reference[c] number	Scientific name	Common name
01	*Baiomys taylori*	Northern pygmy mouse
02	*Blarina* spp.[d]	Short-tailed shrew
03	*Cryptotis parva*	Least shrew
04	*Neotoma floridana*	Eastern woodrat
05	*Ochrotomys nuttalli*	Golden mouse
06	*Peromyscus gossypinus*	Cotton mouse
07	*Peromyscus leucopus*	White-footed mouse
08	*Reithrodontomys fulvescens*	Fulvus harvest mouse
09	*Acris crepitans*	Northern cricket frog
10	*Agkistrodon contortrix*	Copperhead
11	*Anolis carolinensis*	Green anole
12	*Bufo valliceps*	Gulf coast toad
13	*Bufo woodhousii* (*velatus*)	Fowler's toad
14	*Elaphe obsoleta*	Texas ratsnake
15	*Eumeces fasciatus*	Five-lined skink
16	*Eumeces laticeps*	Broadhead skink
17	*Gastrophryne carolinensis*	Eastern narrowmouth toad
18	*Masticophis flagellum*	Coachwhip
19	*Opheodrys aestivus*	Rough green snake
20	*Rana clamitans*	Bronze frog
21	*Rana utricularia*	Southern leopard frog
22	*Sceloporus undulatus*	Fence lizard
23	*Scincella lateralis*	Ground skink
24	*Storeria dekayi*	Brown snake
25	*Thamnophis proximus*	Western ribbon snake

[a] Mammal names follow Whitaker (1996)

[b] Herptile names follow Conant and Collins (1998)

[c] The reference numbers apply to tables and figures interspersed in the text. The numbers do not apply to the full species lists in the appendices.

[d] The *Blarina* species in east Texas has long been assumed to be *B. carolinensis*, but some specimens may be *B. hylophaga* (Schmidly 1983).

Table 12. Spider (*Araneae*) names for species occurring in more than 4 of 60 plots in an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

Reference[a] number	Scientific name[b]	Common name[c]
01	*Ummidia* sp. 1	(spider)
02	*Myrmekiaphila fluviatilis*	(spider)
03	*Agelenopsis emertoni*	(spider)
04	*Agelenopsis kastoni*	(spider)
05	*Agelenopsis naevia*	(spider)
06	*Castianeira amoena*	(spider)
07	*Castianeira longipalpa*	(spider)
08	*Cicurina* sp. nr *ludoviciana*	(spider)
09	*Drassyllus aprilinus*	(spider)
10	*Drassyllus dixinus*	(spider)
11	*Gnaphosa fontinalis*	(spider)
12	*Litopyllus temporarius*	(spider)
13	*Sosticus insularis*	(spider)
14	*Talanites exlineae*	(spider)
15	*Zelotes duplex*	(spider)
16	*Zelotes hentzi*	(spider)
17	*Neoantistea oklahomensis*	(spider)
18	*Allocosa* sp. nr *georgicola*	(spider)
19	*Gladicosa pulchra*	(spider)
20	*Hogna helluo*	(spider)
21	*Pirata apalacheus*	(spider)
22	*Rabidosa punctulata*	(spider)
23	*Rabidosa rabida*	(spider)
24	*Schizocosa crassipes*	(spider)
25	*Schizocosa roverni*	(spider)
26	*Schizocosa saltatrix*	(spider)
27	*Schizocosa stridulans*	(spider)
28	*Schizocosa uetzi*	(spider)
29	*Trochosa acompa*	(spider)
30	*Varacosa avara*	(spider)
31	*Strotarchus piscatorius*	(spider)
32	*Pisaurina dubia*	(spider)

Table 12. Continued.

Reference[a] number	Scientific name[b]	Common name[c]
33	*Pisaurina mira*	Nursery web spider
34	*Anasaitis canosa*	(spider)
35	*Loxosceles reclusa*	Brown recluse
36	*Xysticus ferox*	(spider)
37	*Xysticus fraternus*	(spider)
38	*Xysticus funestus*	(spider)
39	*Xysticus pellax*	(spider)
40	*Titanoeca nigrella*	(spider)

[a] The reference numbers apply to tables and figures interspersed in the text. The numbers do not apply to the full species lists in the appendices.

[b] Spiders were identified to species by Allen Dean, Entomology Department, Texas A&M University.

[c] There were only 2 accepted common names for species in this group.

Table 13. Woody plant (*Dicotyledonae*)[a] names for species occurring in more than 4 of 60 plots in an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

Reference[b] number	Scientific name	Common name
01	*Acer rubrum*	Red maple
02	*Ampelopsis arborea*	Peppervine
03	*Aralia spinosa*	Angelica tree
04	*Baccharis halimifolia*	Eastern baccharis
05	*Berchemia scandens*	Alabama supplejack
06	*Bumelia lanuginosa*	Coma
07	*Callicarpa americana*	American beautyberry
08	*Campsis radicans*	Common trumpet-creeper
09	*Carya alba*	Mockernut hickory
10	*Carya texana*	Black hickory
11	*Celtis laevigata*	Sugar hackberry
12	*Cercis canadensis*	Eastern redbud
13	*Chionanthus virginica*	White fringetree
14	*Cornus florida*	Flowering dogwood
15	*Crataegus crusgallii*	Bushes hawthorne
16	*Crataegus marshallii*	Parsley hawthorne
17	*Crataegus spathulata*	Littlehip hawthorne
18	*Crataegus viridis*	Green hawthorne
19	*Diospyros virginiana*	Common persimmon
20	*Forestiera ligustrina*	Privet forestiera
21	*Fraxinus americana*	White ash
22	*Gelsemium sempervirens*	Carolina jessamine
23	*Gleditsia triacanthos*	Common honey locust
24	*Ilex decidua*	Possum-haw
25	*Ilex opaca*	American holly
26	*Ilex vomitoria*	Yaupon
27	*Juniperus virginiana*	Eastern red cedar
28	*Liquidambar styraciflua*	Sweetgum
29	*Lonicera japonica*	Japanese honeysuckle
30	*Melia azedarach*	Chinaberry
31	*Morus rubra*	Red mulberry
32	*Myrica cerifera*	Southern wax-myrtle
33	*Nyssa sylvatica*	Black-gum
34	*Ostrya virginiana*	Eastern hop hornbeam
35	*Parthenocissus quinquefolia*	Virginia creeper
36	*Pinus echinata*	Shortleaf pine

Table 13. Continued.

Reference[b] number	Scientific name	Common name
37	*Pinus taeda*	Loblolly pine
38	*Prunus mexicana*	Mexican plum
39	*Prunus serotina*	Blackcherry
40	*Quercus falcata*	Southern red oak
41	*Quercus incana*	Bluejack oak
42	*Quercus marilandica*	Blackjack oak
43	*Quercus nigra*	Water oak
44	*Quercus phellos*	Willow oak
45	*Quercus stellata*	Post oak
46	*Quercus velutina*	Black oak
47	*Rhamnus caroliniana*	Carolina buckthorn
48	*Rhus aromatica*	Fragrant sumac
49	*Rhus copallina*	Flameleaf sumac
50	*Rubus louisianus*	Louisiana blackberry
51	*Rubus arvensis* (*saepescandens*)	Leaning blackberry
52	*Rubus riograndes* (*trivialis*)	Southern dewberry
53	*Sassafras albidum*	Sassafras
54	*Smilax bona-nox*	Saw greenbriar
55	*Smilax glauca*	Cat greenbriar
56	*Smilax laurifolia*	Laurel greenbriar
57	*Symphoricarpos orbiculatus*	Coralberry
58	*Toxicodendron radicans*	Poison oak (ivy)
59	*Toxicodendron toxicarium*	Eastern poison oak
60	*Trachelospermum difforme*	American star jasmine
61	*Ulmus alata*	Winged elm
62	*Vaccinium arboreum*	Farkleberry
63	*Viburnum rufidulum*	Downy viburnum
64	*Vitis aestivalis*	Summer grape
65	*Vitis lincecumii*	Pinewoods grape
66	*Vitis mustangensis*	Mustang grape
67	*Vitis rotundifolia*	Muscadine grape
68	*Zanthoxylum clava-herculis*	Hercules club

[a] Woody plant names follow Hatch et al. (1990).

[b] The reference numbers apply to tables and figures interspersed in the text. The numbers do not apply to the full species lists in the appendices.

Table 14. Logistic regression for ants: The Chi-squared probability[a] for 2 factors, dominant tree (Dominant) and subsoil texture (Soil), based on 3 logistic regressions for each of 23 ant species (1 regression for each factor entered alone, and 1 regression including both factors and the interaction term). Data were obtained on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

		Factor			Strongest association[b]			
Species[c]	Number presences in 60 plots	Dominant Chi-squared probability	Soil Chi-squared probability	Interaction[d] Chi-squared probability	Dominant yes = 1	Soil yes = 1	Best model[e] (Akaike criterion)	R^2 [f]
ANT01	7	0.0105	0.4238	1.0000	1		V = D	0.32
ANT02	5	1.0000	0.0522	1.0000		1	V = S	0.27
ANT03	10	0.2990	0.7306	0.0190	1		V = D S D*S	0.29
ANT04	5	0.0522	0.3533	1.0000	1		V = D S	0.34
ANT05	10	0.0797	0.0122	1.0000		1	V = D S	0.35
ANT06	12	0.0211	0.0255	1.0000	1		V = D S	0.46
ANT07	25	0.0207	0.7935	0.8061	1		V = D	0.12
ANT08	22	0.5925	0.5925	0.5761			V = D or S	0.01
ANT09	22	0.5925	0.0094	0.4757		1	V = S	0.16
ANT10	13	0.3507	0.1255	0.5220		1	V = S	0.06
ANT11	6	1.0000	0.1945	1.0000		1	V = S	0.11
ANT12	5	0.6426	0.6426	0.6935			V = D or S	0.01
ANT13	11	0.3057	0.7542	0.7076	1		V = D	0.02
ANT14	7	0.4238	1.0000	0.4000	1		V = D	0.05
ANT15	6	0.3980	0.3980	0.5108			V = D or S	0.03

Table 14. Continued.

Species[c]	Number presences in 60 plots	Factor: Dominant Chi-squared probability	Factor: Soil Chi-squared probability	Interaction[d] Chi-squared probability	Strongest association[b]: Dominant yes = 1	Strongest association[b]: Soil yes = 1	Best model[e] (Akaike criterion)	$R^{2\,f}$
ANT16	5	0.6426	0.6426	0.6935			V = D or S	0.01
ANT17	17	0.0138	0.3920	0.0659	1		V = D S D*S	0.25
ANT18	7	1.0000	0.4238	0.4000		1	V = S	0.05
ANT19	30	1.0000	0.6058	0.3021		1	V = S	0.01
ANT20	8	1.0000	0.1464	1.0000		1	V = S	0.07
ANT21	6	1.0000	0.0237	1.0000		1	V = S	0.29
ANT22	13	0.3507	0.7539	0.3674	1		V = D	0.02
ANT23	26	0.0398	0.0108	0.7906		1	V = D S	0.24

[a] Exact Chi-squared if a cell count = 0, otherwise asymptotic Chi-squared.

[b] Dominant tree had the strongest association 9 times, subsoil texture 10 times, (4 ties). No significant difference ($P =$ 0.496) based on Wilcoxon Sign Rank test. Normality of the distribution of differences was not rejected (P = 0.133) based on Shapiro-Wilk test. Individually dominant tree was significant ($P < 0.1$) for 7 species (30.4 %) and subsoil texture for 6 species (26.1 %).

[c] The individual species are not relevant here, but the ant (*Formicidae, Mutillidae*) species names can be found in Table 8.

[d] The interaction term was significant for 2 species as shown in the Best model column.

[e] V = Species, D = Dominant, S = Soil, D*S = Interaction; 15 models included dominant tree, 16 models included subsoil texture.

[f] The mean R^2 was 0.15.

Table 15. Logistic regression for beetles: The Chi-squared probability[a] for 2 factors, dominant tree (Dominant) and subsoil texture (Soil), based on 3 logistic regressions for each of 43 beetle species (1 regression for each factor entered alone and 1 regression including both factors and the interaction term). Data were obtained on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

		Factor			Strongest association[b]			
Species[c]	Number presences in 60 plots	Dominant Chi-squared probability	Soil Chi-squared probability	Interaction[d] Chi-squared probability	Dominant yes = 1	Soil yes = 1	Best model[e] (Akaike criterion)	R^{2} [f]
BEET01	19	0.0251	0.0006	1.0000		1	V = S	0.44
BEET02	11	0.1069	0.7389	0.3423	1		V = D	0.08
BEET03	11	0.0056	0.1806	1.0000	1		V = D S	0.33
BEET04	9	0.0881	0.7182	0.8258	1		V = D	0.10
BEET05	8	0.1464	0.4518	0.6229	1		V = D	0.10
BEET06	21	0.7867	0.0177	0.8195		1	V = S	0.13
BEET07	17	0.1569	0.1569	0.9884			V = D S	0.10
BEET08	5	0.3533	0.0522	1.0000		1	V = D S	0.34
BEET09	18	0.0287	0.0960	0.4631	1		V = D S	0.19
BEET10	17	0.0505	0.7746	0.1201	1		V = D	0.10
BEET11	11	0.0056	0.1806	1.0000	1		V = D S	0.33
BEET12	10	1.0000	0.1769	0.4616		1	V = S	0.05
BEET13	17	0.0505	0.1569	0.1029	1		V = D S	0.14
BEET14	7	0.1028	0.1028	0.1000			V = D S D*S	0.44
BEET15	26	0.0108	0.6026	0.0894	1		V = D	0.15
BEET16	7	0.0105	0.4238	1.0000	1		V = D	0.32

Table 15. Continued.

Species[c]	Number presences in 60 plots	Factor: Dominant Chi-squared probability	Factor: Soil Chi-squared probability	Interaction[d] Chi-squared probability	Strongest association[b]: Dominant yes = 1	Strongest association[b]: Soil yes = 1	Best model[e] (Akaike criterion)	R^2 [f]
BEET17	6	0.6707	0.6707	0.4586			V = D	0.03
BEET18	8	1.0000	0.1464	1.0000		1	V = S	0.07
BEET19	10	0.0122	0.2990	1.0000	1		V = D S	0.28
BEET20	17	0.3920	0.7746	0.0145	1		V = D S D*S	0.18
BEET21	17	0.0001	0.5675	1.0000	1		V = D	0.57
BEET22	9	0.1455	0.1455	1.0000			V = D S	0.19
BEET23	15	0.7657	0.7657	0.7549			V = D or V = S	0.00
BEET24	25	0.4330	0.0001	0.1580		1	V = S	0.49
BEET25	5	0.3533	1.0000	1.0000	1		V = D	0.08
BEET26	8	0.1464	0.1464	0.2992			V = D S	0.14
BEET27	6	0.1945	0.1945	1.0000			V = D S	0.22
BEET28	6	0.1945	1.0000	1.0000	1		V = D	0.11
BEET29	6	0.0237	0.6707	1.0000	1		V = D	0.29
BEET30	10	0.7306	0.0797	0.0988		1	V = S	0.12
BEET31	5	0.3533	0.0522	1.0000		1	V = D S	0.34
BEET32	17	0.0037	0.1569	0.8242	1		V = D S	0.28
BEET33	15	0.0001	1.0000	1.0000	1		V = D	0.52
BEET34	10	0.0797	0.7306	0.4493	1		V = D	0.12
BEET35	6	0.0237	0.1945	1.0000	1		V = D S	0.40
BEET36	12	0.5202	0.2042	0.3951		1	V = S	0.04
BEET37	7	1.0000	0.1028	1.0000		1	V = S	0.14

Table 15. Continued.

		Factor			Strongest association[b]			
Species[c]	Number presences in 60 plots	Dominant Chi-squared probability	Soil Chi-squared probability	Interaction[d] Chi-squared probability	Dominant yes = 1	Soil yes = 1	Best model[e] (Akaike criterion)	R^2 [f]
BEET38	10	0.7306	0.0008	1.0000		1	V = S	0.39
BEET39	10	0.0008	0.7306	1.0000	1		V = D	0.39
BEET40	8	0.0046	0.7065	1.0000	1		V = D	0.34
BEET41	6	0.1945	0.0237	1.0000		1	V = D S	0.40
BEET42	8	0.0523	0.7065	0.3367	1		V = D	0.17
BEET43	17	0.3920	0.3920	0.0429			V = D S D*S	0.15

[a] Exact Chi-squared if a cell count = 0, otherwise asymptotic Chi-squared.

[b] Dominant tree had the strongest association 23 times, subsoil texture 12 times, (8 ties). The difference was significant (P = 0.090) based on Wilcoxon Sign test. Normality of the distribution of differences was rejected (P = 0.035) based on the Shapiro-Wilk test. Individually dominant tree was significant (P < 0.1) for 19 species (44.2 %) and subsoil texture for 9 species (20.9 %).

[c] The individual species are not relevant here, but the beetle species names can be found in Table 9.

[d] The interaction term was significant for 3 species as shown in the Best model column.

[e] V = Species, D = Dominant, S = Soil, D*S = Interaction; 34 models included dominant tree, 27 models included subsoil texture.

[f] The mean R^2 was 0.23.

Table 16. Logistic regression for birds: The Chi-squared probability[a] for 2 factors, dominant tree (Dominant) and subsoil texture (Soil), based on 3 logistic regressions for each of 28 bird species (1 regression for each factor entered alone, and 1 regression including both factors and the interaction term). Data were obtained on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

		Factor			Strongest association[b]			
Species[c]	Number[d] presences in 60 plots	Dominant Chi-squared probability	Soil Chi-squared probability	Interaction[e] Chi-squared probability	Dominant yes = 1	Soil yes = 1	Best model[f] (Akaike criterion)	R^2 [g]
BIRD01	10	0.0122	0.0797	1.0000	1		V = D S	0.35
BIRD02	17	0.0001	0.5675	1.0000	1		V = D	0.43
BIRD03	59							
BIRD04	13	0.0001	0.5321	1.0000	1		V = D	0.47
BIRD05	37	0.0011	0.4267	0.2460	1		V = D	0.25
BIRD06	36	0.0379	0.2936	0.8909	1		V = D	0.10
BIRD07	11	0.7389	0.7389	0.3304			V = D or S	0.00
BIRD08	50	0.1769	0.4910	0.2208	1		V = D	0.05
BIRD09	54	0.0237	0.6707	1.0000	1		V = D	0.29
BIRD10	50	0.4910	1.0000	1.0000	1		V = D	0.01
BIRD11	5	1.0000	0.3533	1.0000		1	V = S	0.08
BIRD12	11	0.7389	0.7389	0.7194			V = D or S	0.00
BIRD13	40	0.5844	0.5844	0.2607			V = D or S	0.01
BIRD14	6	0.0237	1.0000	1.0000	1		V = D	0.29
BIRD15	11	0.0056	1.0000	1.0000	1		V = D	0.25
BIRD16	13	0.7542	0.7542	0.3401			V = D or S	0.00
BIRD17	30	0.0114	0.0413	0.2474	1		V = D S	0.24
BIRD18	7	0.0105	0.4238	1.0000	1		V = D	0.32

Table 16. Continued.

		Factor			Strongest association[b]			
Species[c]	Number[d] presences in 60 plots	Dominant Chi-squared probability	Soil Chi-squared probability	Interaction[e] Chi-squared probability	Dominant yes = 1	Soil yes = 1	Best model[f] (Akaike criterion)	R^2 [g]
BIRD19	55	0.0522	1.0000	1.0000	1		V = D	0.27
BIRD20	32	0.0005	0.0026	0.7423	1		V = D S	0.49
BIRD21	42	0.0007	0.2630	0.5054	1		V = D	0.35
BIRD22	10	0.4910	0.4910	0.5501			V = D or S	0.01
BIRD23	5	0.3533	1.0000	1.0000	1		V = D	0.08
BIRD24	11	0.0003	1.0000	1.0000	1		V = D	0.42
BIRD25	6	0.1945	0.1945	1.0000			V = D S	0.22
BIRD26	26	0.0001	0.4348	1.0000	1		V = D S	0.89
BIRD27	16	0.0009	0.7710	0.4499	1		V = D	0.29
BIRD28	20	0.5844	0.1045	0.2240		1	V = S	0.06
BIRD29	41	0.7814	0.7814	0.0040			V = D S D*S	0.21
BIRD30	58							

[a] Exact Chi-squared if a cell count = 0, otherwise asymptotic Chi-squared.

[b] Dominant tree had the strongest association 19 times, subsoil texture 2 times, (7 ties). The difference was significant (P < 0.001) based on Wilcoxon Signed Rank test. Normality of the distribution of differences was not rejected (P = 0.109) based on Shapiro-Wilk test. Individually dominant tree was significant (P < 0.1) for 16 species (53.3 %) and subsoil texture for 3 species (10.0 %).

[c] The individual species are not relevant here, but the bird species names can be found in Table 10.

[d] Species present in more than 55 plots are used for percentages, but not used in regressions (unstable, same as for <5 present).

[e] The interaction term was significant for 1 species as shown in the Best model column.

[f] V = Species, D = Dominant, S = Soil, D*S = Interaction; 26 models included dominant tree, 13 models included subsoil texture.

[g] The mean R^2 was 0.23.

Table 17. Logistic regression for herptile and small mammal species: The Chi-squared probability[a] for 2 factors, dominant tree (Dominant) and subsoil texture (Soil), based on 3 logistic regressions for each of 25 herp and small mammal species (1 regression for each factor entered alone and 1 regression including both factors and the interaction term). Data were obtained on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

		Factor			Strongest association[b]			
Species[c]	Number presences in 60 plots	Dominant Chi-squared probability	Soil Chi-squared probability	Interaction[d] Chi-squared probability	Dominant yes = 1	Soil yes = 1	Best model[e] (Akaike criterion)	R^{2} [f]
HM01	15	0.0120	0.1423	0.8014	1		V = D S	0.23
HM02	9	0.1455	0.1455	1.0000			V = D S	0.19
HM03	11	0.7389	0.3221	0.2775		1	V = S	0.03
HM04	14	0.0751	1.0000	1.0000	1		V = D	0.08
HM05	13	0.2092	0.2092	0.2140			V = D S D*S	0.21
HM06	33	0.4371	0.4371	0.0718			V = D S D*S	0.10
HM07	32	0.0005	0.6050	0.2606	1		V = D	0.27
HM08	12	0.2042	0.5202	0.0757	1		V = D S D*S	0.14
HM09	6	0.1945	1.0000	1.0000	1		V = D	0.11
HM10	13	0.0011	1.0000	0.4355	1		V = D	0.31
HM11	5	0.3533	1.0000	1.0000	1		V = D	0.08
HM12	18	0.5737	1.0000	0.2609	1		V = D	0.01
HM13	8	0.2542	0.0523	1.0000		1	V = D S	0.24
HM14	7	0.6885	0.6885	0.6467			V = D or V = S	0.01
HM15	26	0.1208	0.2990	0.0395	1		V = D S D*S	0.17

Table 17. Continued.

Species[c]	Number presences in 60 plots	Factor: Dominant Chi-squared probability	Factor: Soil Chi-squared probability	Interaction[d] Chi-squared probability	Strongest association[b]: Dominant yes = 1	Strongest association[b]: Soil yes = 1	Best model[e] (Akaike criterion)	R^{2} [f]
HM16	5	0.0522	0.3533	1.0000	1		V = D S	0.34
HM17	10	0.0008	0.7306	1.0000	1		V = D	0.39
HM18	19	0.0158	0.1691	0.6247	1		V = D S	0.19
HM19	5	1.0000	0.3533	1.0000		1	V = S	0.09
HM20	13	0.2092	0.0011	1.0000		1	V = D S	0.37
HM21	14	1.0000	0.5427	0.2244		1	V = S	0.01
HM22	11	0.1806	0.0056	1.0000		1	V = D S	0.25
HM23	52	0.0523	1.0000	1.0000	1		V = D	0.17
HM24	15	0.7657	0.0438	0.1412		1	V = S	0.11
HM25	14	0.5427	0.2274	0.1745		1	V = S	0.04

[a] Exact Chi-squared if a cell count = 0, otherwise asymptotic Chi-squared.

[b] Dominant tree had the strongest association 13 times, subsoil texture 8 times, (4 ties). The difference was not significant (P = 0.159) based on Wilcoxon Signed Rank test. Normality of the distribution of differences was not rejected (P = 0.488) based on Shapiro-Wilk test. Individually dominant tree was significant ($P < 0.1$) for 8 species (32.0 %) and subsoil texture for 4 species (16.0 %).

[c] The individual species are not relevant here, but the herptile and small mammal species names can be found in Table 11.

[d] The interaction term was significant for 4 species as shown in the Best model column.

[e] V = Species, D = Dominant, S = Soil, D*S = Interaction; 20 models included dominant tree, 17 models included subsoil texture.

[f] The mean R^2 was 0.17.

Table 18. Logistic regression for spiders: The Chi-squared probability[a] for 2 factors, dominant tree (Dominant) and subsoil texture (Soil), based on 3 logistic regressions for each of 40 spider species (1 regression for each factor entered alone and 1 regression including both factors and the interaction term). Data were obtained on an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

		Factor			Strongest association[b]			
Species[c]	Number presences in 60 plots	Dominant Chi-squared probability	Soil Chi-squared probability	Interaction[d] Chi-squared probability	Dominant yes = 1	Soil yes = 1	Best model[e] (Akaike criterion)	R^2 [f]
SPID01	5	0.3533	1.0000	0.3824	1		V = D	0.08
SPID02	16	0.2469	0.0249	0.6288		1	V = S	0.13
SPID03	11	0.7389	0.3221	0.7864		1	V = S	0.03
SPID04	10	0.2990	0.7306	0.1768	1		V = D S D*S	0.18
SPID05	15	0.7657	0.1423	0.7005		1	V = S	0.05
SPID06	7	0.4238	1.0000	0.4000	1		V = D	0.05
SPID07	6	0.6707	1.0000	0.3662	1		V = D S D*S	0.16
SPID08	7	0.6885	0.6885	0.6467			V = D or S	0.01
SPID09	23	0.4267	0.4267	0.7568			V = D or S	0.01
SPID10	15	0.0002	0.2326	0.2143	1		V = D S D*S	0.48
SPID11	8	1.0000	0.0046	1.0000		1	V = S	0.34
SPID12	5	1.0000	1.0000	0.3756			V = D or S	0.01
SPID13	8	0.1464	0.4518	0.6299	1		V = D	0.07
SPID14	27	0.1967	0.7953	0.0696	1		V = D	0.04
SPID15	10	0.1769	1.0000	0.4616	1		V = D	0.05
SPID16	23	0.7907	0.1871	0.7691		1	V = S	0.04

Table 18. Continued.

Species[c]	Number presences in 60 plots	Factor: Dominant Chi-squared probability	Factor: Soil Chi-squared probability	Interaction[d] Chi-squared probability	Strongest association[b]: Dominant yes = 1	Strongest association[b]: Soil yes = 1	Best model[e] (Akaike criterion)	R^{2} [f]
SPID17	7	1.0000	0.0105	1.0000		1	V = S	0.32
SPID18	5	1.0000	0.3533	0.3824		1	V = S	0.08
SPID19	13	0.3507	0.3507	0.1511			V = D or S	0.02
SPID20	49	0.5062	0.0056	1.0000		1	V = S	0.25
SPID21	8	0.0046	1.0000	1.0000	1		V = D	0.34
SPID22	13	0.0371	0.1255	0.7506	1		V = D S	0.19
SPID23	30	0.1239	0.6058	0.5976	1		V = D	0.05
SPID24	5	1.0000	0.3533	1.0000		1	V = S	0.08
SPID25	27	0.0054	0.7953	0.0161	1		V = D S D*S	0.29
SPID26	26	0.2990	0.2990	0.5679			V = D or S	0.04
SPID27	14	0.0303	0.0303	1.0000			V = D S	0.30
SPID28	11	0.5062	0.1806	0.4441		1	V = D S D*S	0.19
SPID29	11	0.7389	0.7389	0.0322			V = D S D*S	0.15
SPID30	32	0.6050	0.0410	0.5759		1	V = S	0.09
SPID31	12	1.0000	1.0000	0.0188			V = D S D*S	0.18
SPID32	5	0.1124	1.0000	1.0000	1		V = D	0.24
SPID33	27	0.1967	0.0721	0.0535		1	V = D S D*S	0.19
SPID34	5	0.3533	0.0522	1.0000		1	V = D S	0.34
SPID35	9	1.0000	0.0257	0.4231		1	V = S	0.20
SPID36	25	0.4330	0.7935	0.4354	1		V = D	0.01

Table 18. Continued.

Species[c]	Number presences in 60 plots	Factor: Dominant Chi-squared probability	Factor: Soil Chi-squared probability	Interaction[d] Chi-squared probability	Strongest association[b]: Dominant yes = 1	Strongest association[b]: Soil yes = 1	Best model[e] (Akaike criterion)	R^2 [f]
SPID37	7	0.1028	0.4238	1.0000	1		V = D	0.14
SPID38	10	0.4910	0.1769	0.2208		1	V = S	0.05
SPID39	7	0.1028	1.0000	0.9708	1		V = D	0.14
SPID40	11	0.7389	0.7389	0.0322			V = D S D*S	0.15

[a] Exact Chi-squared if a cell count = 0, otherwise asymptotic Chi-squared.

[b] Dominant tree had the strongest association 16 times, subsoil texture 15 times, (9 ties). The difference was not significant (P = 0.871) based on Wilcoxon Signed Rank test. Normality of the distribution of differences was not rejected (P = 0.308) based on Shapiro-Wilk test. Individually dominant tree was significant (P < 0.1) for 5 species (12.5 %) and subsoil texture for 9 species (22.5 %).

[c] The individual species are not relevant here, but the spider species names can be found in Table 12.

[d] The interaction term was significant for 9 species as shown in the Best model column.

[e] V = Species, D = Dominant, S = Soil, D*S = Interaction; 28 models included dominant tree, 29 models included subsoil texture.

[f] The mean R^2 was 0.14.

Table 19. Logistic regression for woody plants: The Chi-squared probability[a] for 2 factors, dominant tree (Dominant) and subsoil texture (Soil), based on 3 logistic regressions for each of 68 woody plant species (1 regression for each factor entered alone, and 1 regression including both factors and the interaction term). Data were obtained from an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002.

		Factor			Strongest association[b]			
Species[c]	Number[d] presences in 60 plots	Dominant Chi-squared probability	Soil Chi-squared probability	Interaction[e] Chi-squared probability	Dominant yes = 1	Soil yes = 1	Best model[f] (Akaike criterion)	R^2 [g]
VGW01	13	0.0001	0.0102	1.0000	1		V = D S	0.66
VGW02	34	0.0005	0.1208	0.1216	1		V = D S	0.33
VGW03	6	0.1945	0.6707	1.0000	1		V = D	0.11
VGW04	14	0.0303	0.0004	1.0000		1	V = D S	0.49
VGW05	44	0.5601	0.0067	0.7381		1	V = S	0.20
VGW06	30	0.6058	1.0000	0.3021	1		V = D	0.01
VGW07	59							
VGW08	20	0.0322	0.1045	0.3096	1		V = D S	0.17
VGW09	8	0.0046	0.0523	1.0000	1		V = D S	0.50
VGW10	51	0.0019	0.0019	1.0000			V = D S	0.70
VGW11	20	0.5844	1.0000	0.1035	1		V = D	0.01
VGW12	13	0.3507	0.1255	0.4706		1	V = S	0.06
VGW13	6	0.0237	1.0000	1.0000	1		V = D	0.29
VGW14	36	0.0379	0.0005	0.0130		1	V = D S D*S	0.50
VGW15	14	0.1253	0.3604	0.1775	1		V = D S D*S	0.22
VGW16	32	0.3021	0.0001	0.2591		1	V = S	0.35
VGW17	22	0.5925	0.0354	0.9246		1	V = S	0.10

Table 19. Continued.

Species[c]	Number[d] presences in 60 plots	Factor		Interaction[e] Chi-squared probability	Strongest association[b]		Best model[f] (Akaike criterion)	$R^{2\ g}$
		Dominant Chi-squared probability	Soil Chi-squared probability		Dominant yes = 1	Soil yes = 1		
VGW18	7	1.0000	0.1028	1.0000		1	V = S	0.14
VGW19	50	0.1769	0.1769	0.0831			V = D S D*S	0.20
VGW20	35	0.7935	0.0002	0.0467		1	V = D S D*S	0.40
VGW21	38	0.1115	0.0094	0.1603		1	V = D S D*S	0.25
VGW22	5	0.0522	1.0000	1.0000	1		V = D	0.27
VGW23	18	0.7787	0.0001	1.0000		1	V = S	0.60
VGW24	26	0.6026	0.0005	0.0705		1	V = D S D*S	0.35
VGW25	36	0.0379	0.0001	0.2459		1	V = D S	0.56
VGW26	56							
VGW27	45	0.0002	1.0000	1.0000	1		V = D	0.37
VGW28	37	0.0002	0.0194	0.5032	1		V = D S	0.46
VGW29	7	0.1020	0.4238	1.0000	1		V = D	0.14
VGW30	6	0.1945	1.0000	1.0000	1		V = D	0.11
VGW31	40	0.7847	1.0000	0.2634	1		V = D	0.01
VGW32	18	0.0001	0.0101	1.0000	1		V = D S	0.54
VGW33	24	0.0102	0.2936	0.4471	1		V = D	0.15
VGW34	13	0.0371	0.1255	0.7506	1		V = D S	0.19
VGW35	48	0.5202	0.5202	0.9333				0.01
VGW36	26	0.0001	0.7948	1.0000	1		V = D	0.84
VGW37	26	0.0001	0.7948	1.0000	1		V = D	0.84
VGW38	27	0.0217	0.1967	0.1419	1		V = D S D*S	0.20
VGW39	18	0.0020	0.5737	0.2878	1		V = D	0.26

Table 19. Continued.

Species[c]	Number[d] presences in 60 plots	Factor: Dominant Chi-squared probability	Factor: Soil Chi-squared probability	Interaction[e] Chi-squared probability	Strongest association[b]: Dominant yes = 1	Strongest association[b]: Soil yes = 1	Best model[f] (Akaike criterion)	R^{2} [g]
VGW40	36	0.0001	0.7925	0.6684	1		V = D	0.65
VGW41	23	0.2882	0.0001	1.0000		1	V = D S	0.66
VGW42	37	0.1871	0.4267	0.1993	1		V = D	0.04
VGW43	50	0.1769	0.1769	0.7957				0.11
VGW44	29	0.0002	0.0379	0.1547	1		V = D S D*S	0.43
VGW45	58							
VGW46	5	0.0237	0.1945	1.0000	1		V = D S	0.40
VGW47	14	0.0065	0.2274	0.4900	1		V = D	0.23
VGW48	22	0.4220	0.0001	0.4580		1	V = D S D*S	0.46
VGW49	30	0.0026	0.1239	1.0000	1		V = D S	0.26
VGW50	8	0.2542	0.0523	1.0000		1	V = D S	0.24
VGW51	7	0.1028	0.4238	0.2391	1		V = D S D*S	0.28
VGW52	23	0.4267	0.4267	0.0689			V = D S D*S	0.10
VGW53	33	0.0217	0.0001	0.5965		1	V = D S	0.52
VGW54	58							
VGW55	29	0.1986	0.0012	0.8086		1	V = D S	0.27
VGW56	42	0.5737	0.0075	0.3785		1	V = S	0.18
VGW57	16	0.0009	0.0074	1.0000	1		V = D S	0.50
VGW58	49	0.5062	0.0419	0.0700		1	V = D S D*S	0.31
VGW59	11	1.0000	0.0003	1.0000		1	V = S	0.42
VGW60	17	0.0204	0.0204	1.0000			V = D S	0.31
VGW61	57							

Table 19. Continued.

Species[c]	Number[d] presences in 60 plots	Factor: Dominant Chi-squared probability	Factor: Soil Chi-squared probability	Interaction[e] Chi-squared probability	Strongest association[b]: Dominant yes = 1	Strongest association[b]: Soil yes = 1	Best model[f] (Akaike criterion)	R^{2} [g]
VGW62	51	0.2864	0.7182	0.6263	1		V = D	0.03
VGW63	38	0.1115	1.0000	0.0321	1		V = D S D*S	0.16
VGW64	18	0.0001	1.0000	1.0000	1		V = D	0.46
VGW65	26	0.2990	0.0001	0.7956		1	V = D S	0.56
VGW66	19	0.4066	0.0566	0.1092		1	V = S	0.09
VGW67	56							
VGW68	18	0.0960	0.5737	0.0720	1		V = D S D*S	0.16

[a] Exact Chi-squared if a cell count = 0, otherwise asymptotic Chi-squared.

[b] Dominant tree had the strongest association 34 times, subsoil texture 22 times, (6 ties). The difference was not significant (P < 0.197) based on Wilcoxon Signed Rank test. Normality of the distribution of differences was not rejected (P = 0.132) based on Shapiro-Wilk test. Individually dominant tree was significant (P < 0.1) for 29 species (42.6 %) and subsoil texture for 28 species (41.2 %).

[c] The individual species are not relevant here, but the woody plant names can be found in Table 13.

[d] Species present in more than 55 plots are used for percentages, but not used in regressions (unstable, same as for <5 present).

[e] The interaction term was significant for 14 species as shown in the Best model column.

[f] V = Species, D = Dominant, S = Soil, D*S = Interaction; 51 models included dominant tree, 42 models included subsoil texture.

[g] The mean R^2 was 0.31.

For the distribution of individual species there was often a significant ($P <$ 0.1) association with either dominant or soil. For 2 groups (beetles and birds) there was a significantly ($P < 0.1$) stronger association of dominant with their species distributions than for soil. Soil did not have the strongest association with the distribution of species within a group for any group.

CCA and RDA

For the 16 factors initially considered (Table 2 and Fig. 2), the strongest associated factor for each group was: ants (pcSand), beetles (drought), birds (Pine1), MamHerp (drought), spiders (drought), woody (pcSand); (Figs. 3–8). Thus for 3 groups drought was the factor most strongly associated with the distributions of their species. For 2 groups pcSand was the strongest factor. For 1 group Pine1 was the strongest factor.

For the 9 factors subsequently chosen for the study, the strongest associated factor (Table 20) for each group was: ants (Sand1), beetles (Pine1), birds (Pine1), MamHerp (Pine1), spiders (GrzClass), woody (Pine1); (Figs. 3–8). Thus for 4 groups Pine1 was the most important factor. For 1 group Sand1 was the most important factor. For 1 group GrzClass was the most important factor. For the first 2 factors selected Sand1 was selected 6 times, Pine1 was selected 4 times, and GrzClass 2 times.

Comparing Pine1 and Sand1 each entered alone (the study objective), Pine1 was most significant for 2 groups, Sand1 for 1 group, and they were tied

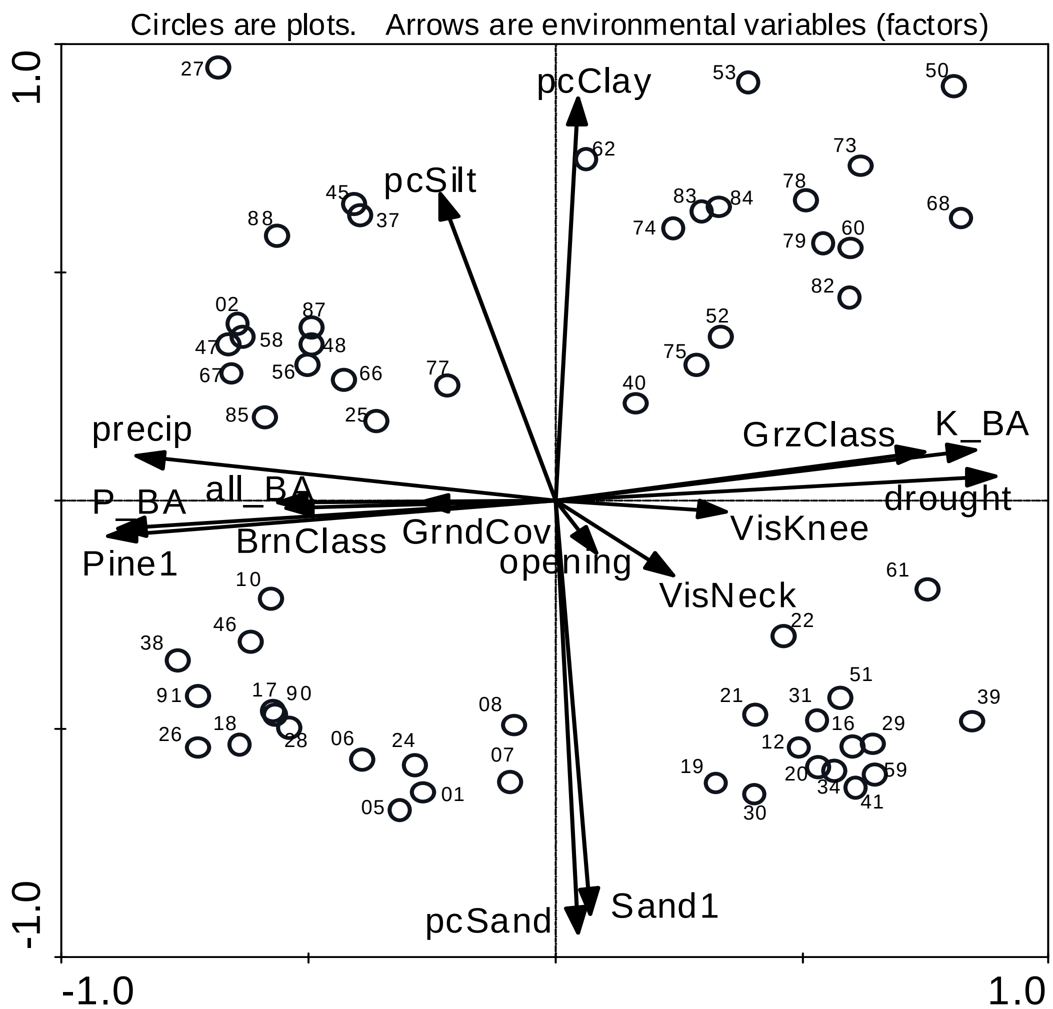


Fig. 2. Plots clustered into 4 groups in factor space because of the values in each plot for the factors related to dominant tree and subsoil texture. The factor arrows P_BA and K_BA indicate increasing pine and post oak basal area respectively. The factor arrows pcSand, pcSilt, and pcClay indicate increasing percentages of sand, silt, and clay respectively. Factors are described in more detail in the footnotes of Table 2.

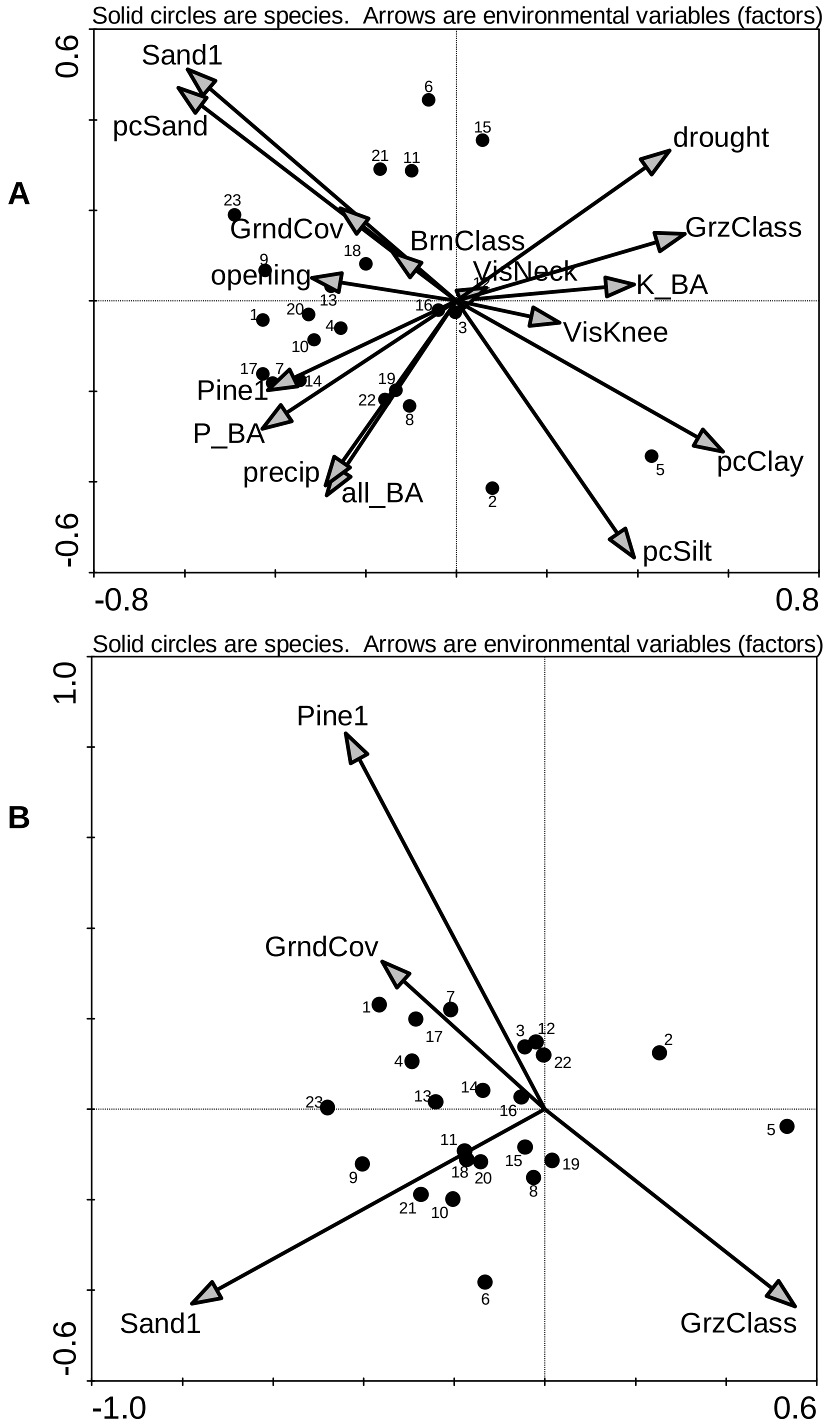


Fig. 3. Ants. Image A shows the relationship of 16 factors with ant species. Image B shows the relationship of 4 factors after highly correlated factors have been removed and the best 4 factors selected automatically by CANOCO®.

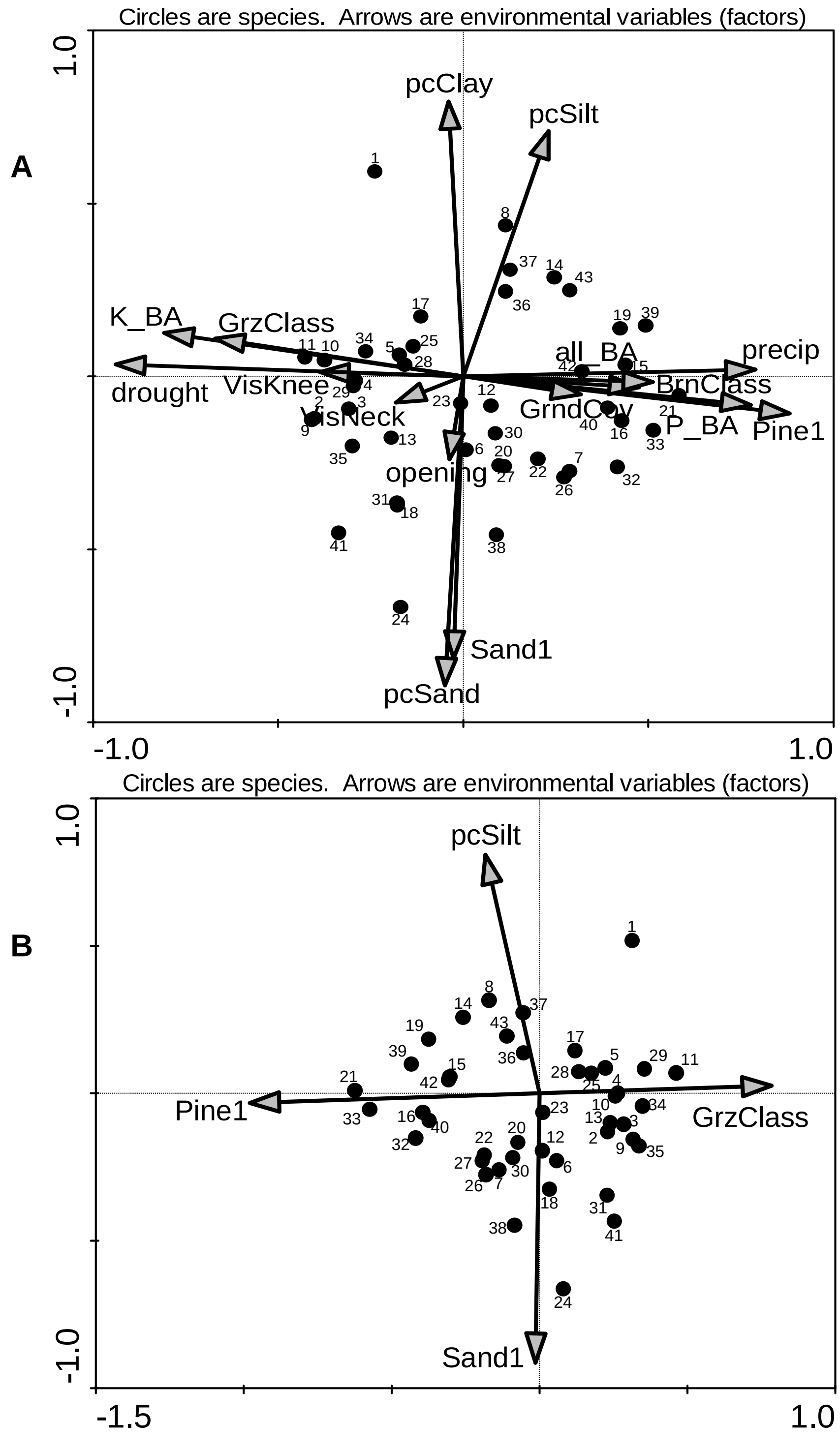
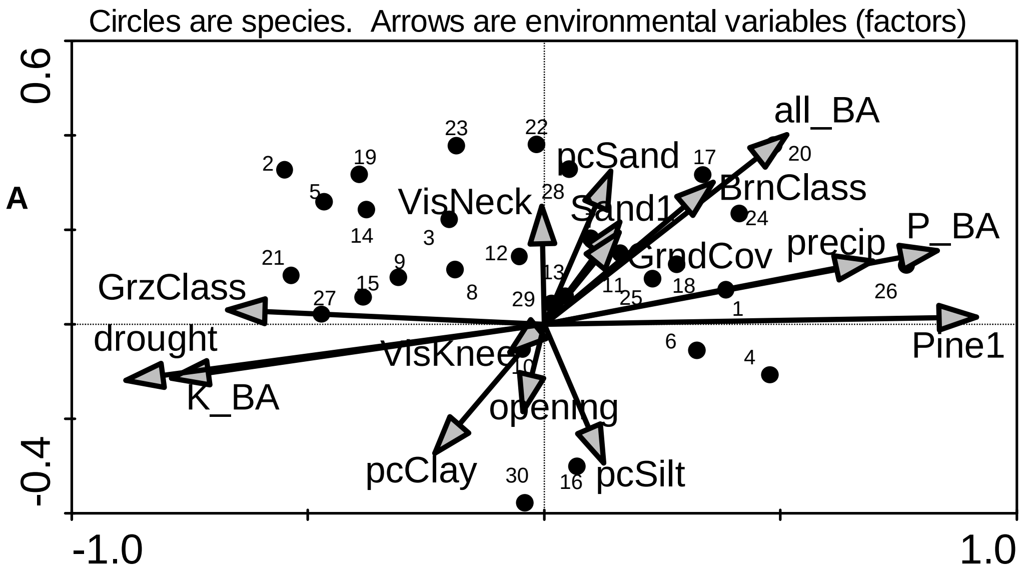


Fig. 4. Beetles. Image A shows the relationship of 16 factors with beetle species. Image B shows the relationship of 4 factors after highly correlated factors have been removed and the best 4 factors selected automatically by CANOCO®.



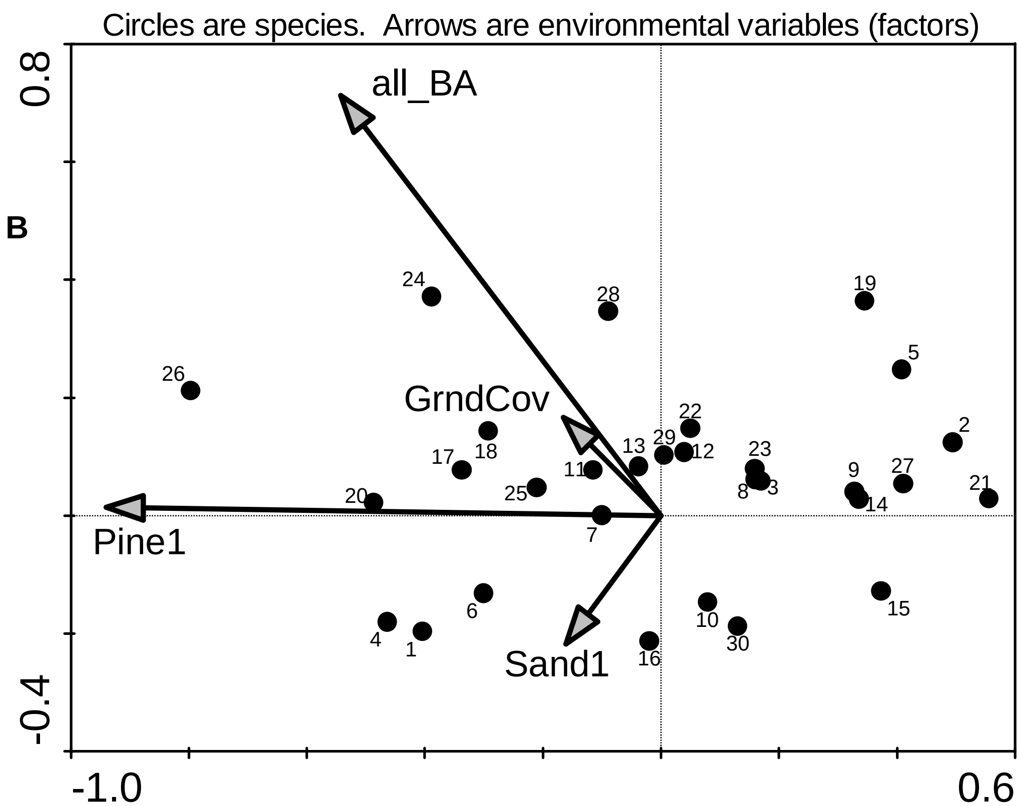


Fig. 5. Birds. Image A shows the relationship of 16 factors with bird species indicating birds as a group are more associated with tree factors than soil factors (e.g., pine basal area [P_BA] relative to percent silt [pcSilt]). Image B shows the relationship of 4 factors after highly correlated factors have been removed and the best 4 factors selected automatically by CANOCO®.

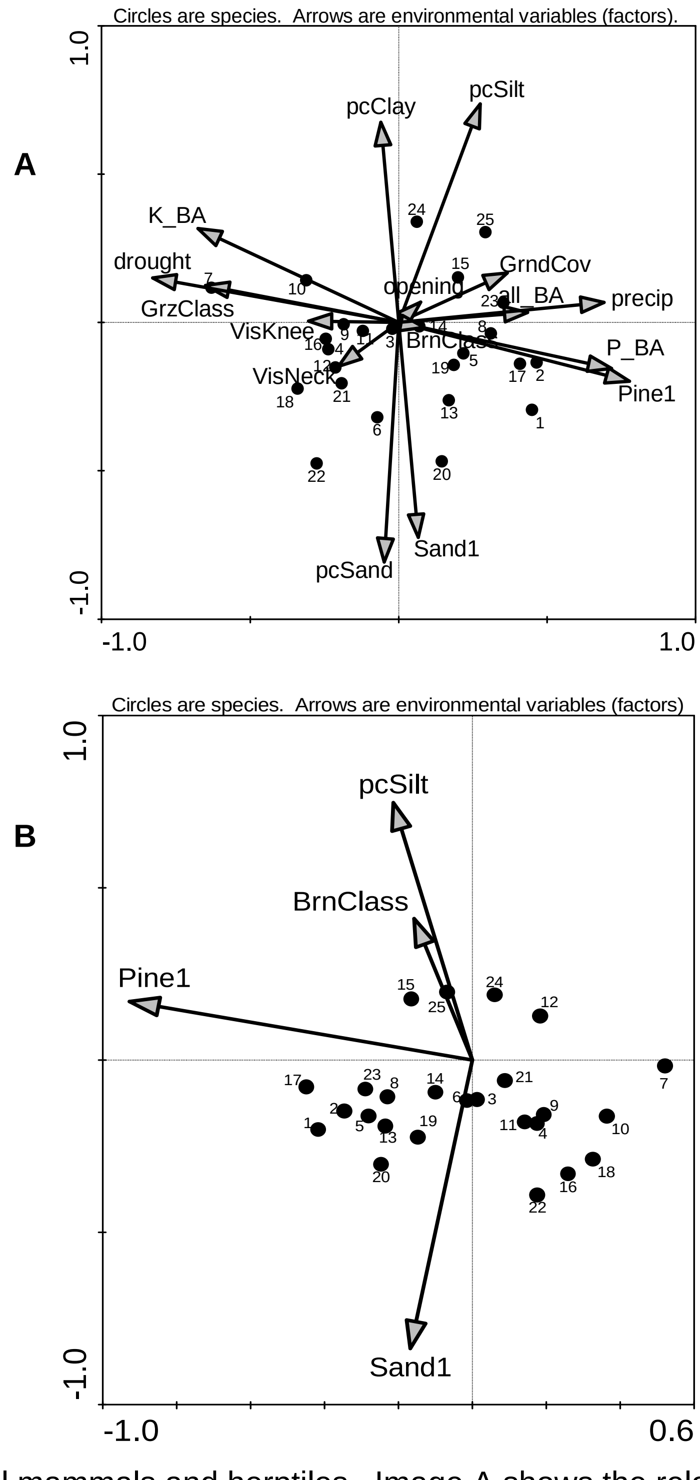


Fig. 6. Small mammals and herptiles. Image A shows the relationship of species with 16 factors. Image B shows the relationship of 4 factors after the highly correlated factors have been removed and the best 4 factors automatically selected by CANOCO®.

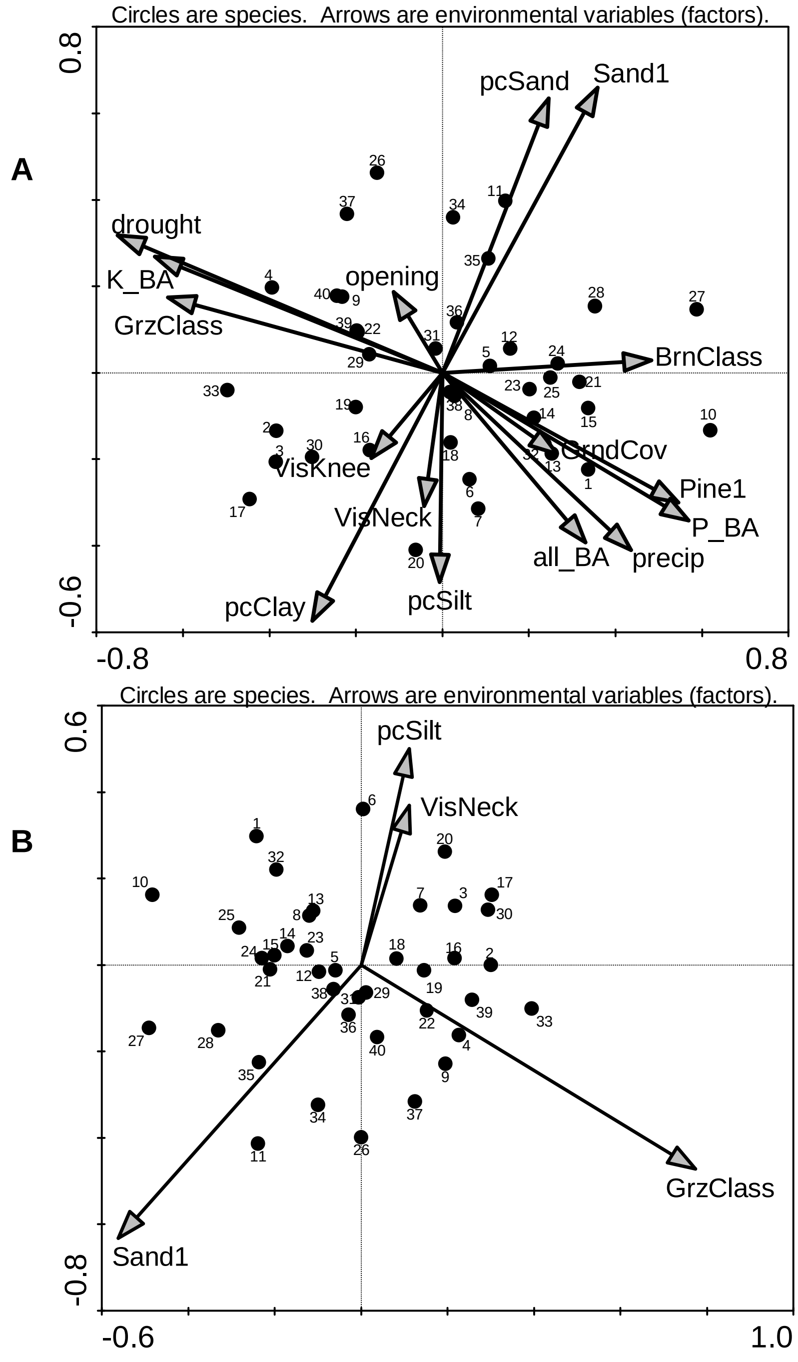


Fig. 7. Spiders. Image A shows the relationship of spider species with 16 factors. Image B shows the relationship of 4 factors after the highly correlated factors have been removed and the best 4 factors automatically selected by CANOCO®.

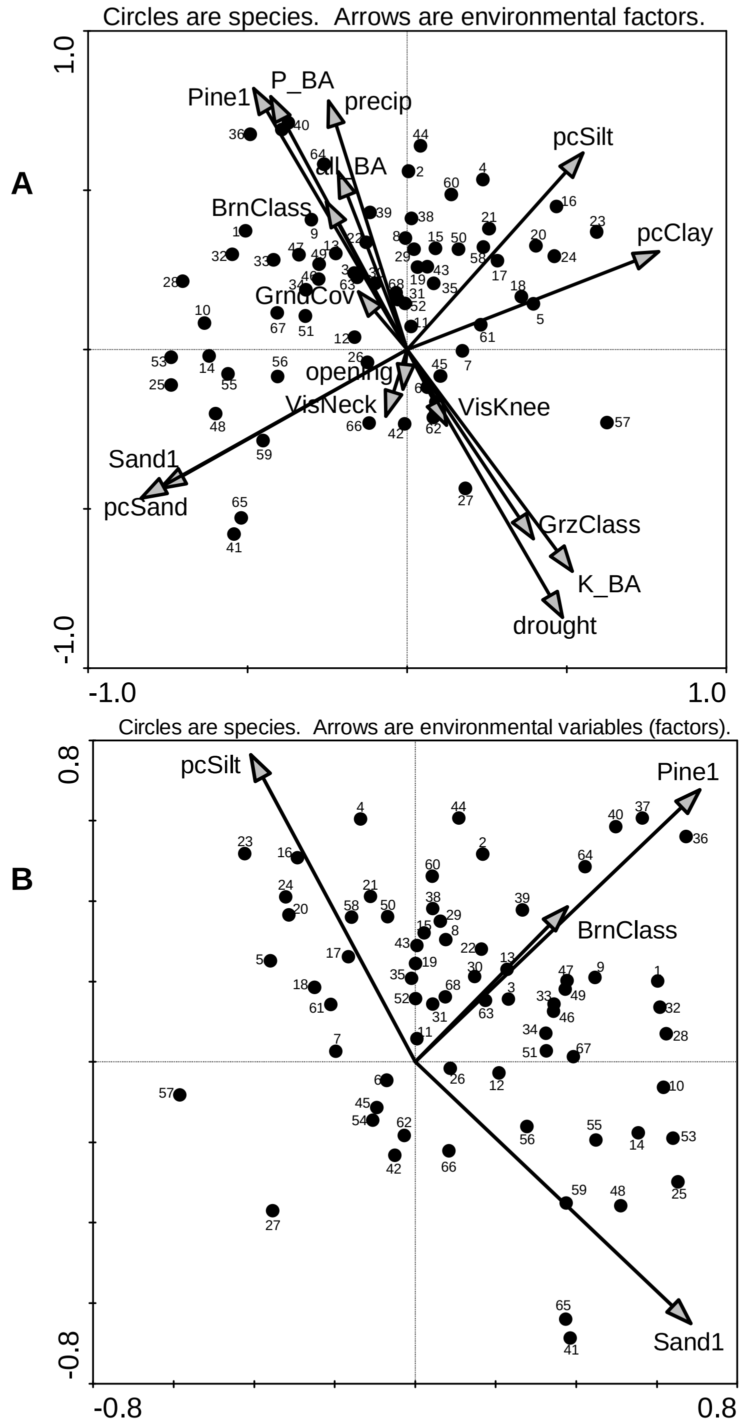


Fig. 8. Woody plants. Image A shows the relationship of woody plants species with 16 factors. Image B shows the relationship of 4 factors after highly correlated factors have been removed and the best 4 factors automatically selected by CANOCO®.

Table 20. Redundancy analysis (RDA): For each species group a measure of the strength of association with the environmental variables[a] is given for Pine1 and Sand1 alone, and for the first 4 variables selected by automatic forward selection[b]. Data were obtained from an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002[c].

	Entered individually		Entered 4 together			
Species[d] Group	Variable	Variable	First variable selected	Second variable selected	Third variable selected	Fourth variable selected
Ants	Pine1 (*P* = 0.024)	Sand1 (*P* = 0.004)	Sand1 (*P* = 0.004)	GrzClass (*P* = 0.010)	Pine1 (*P* = 0.174)	GrndCov (*P* = 0.176)
Beetles	Pine1 (*P* = 0.002)	Sand1 (*P* = 0.002)	Pine1 (*P* = 0.002)	Sand1 (*P* = 0.002)	pcSilt (*P* = 0.002)	GrzClass (*P* = 0.028)
Birds	Pine1 (*P* = 0.002)	Sand1 (*P* = 0.080)	Pine1 (*P* = 0.002)	Sand1 (*P* = 0.026)	all_BA (*P* = 0.022)	GrndCov (*P* = 0.206)
MamHerp	Pine1 (*P* = 0.002)	Sand1 (*P* = 0.012)	Pine1 (*P* = 0.002)	Sand1 (*P* = 0.014)	BrnClass (*P* = 0.020)	pcSilt (*P* = 0.066)
Spiders	Pine1 (*P* = 0.004)	Sand1 (*P* = 0.004)	GrzClass (*P* = 0.002)	Sand1 (*P* = 0.002)	pcSilt (*P* = 0.198)	VisNeck (*P* = 0.148)
Woody	Pine1 (*P* = 0.002)	Sand1 (*P* = 0.002)	Pine1 (*P* = 0.002)	Sand1 (*P* = 0.002)	pcSilt (*P* = 0.002)	BrnClass (*P* = 0.060)

[a] Environmental variables (factors) are defined as

Pine1: Dominant tree, categorical: Pine = 1, Post oak = 0.

Sand1: Soil texture (PSD), categorical: Sand1 = 1 if sand >70% (clay <9%), otherwise = 0.

all_BA: Basal area in m^2/ha for all tree species (trees < 25 cm DBH not included).

pcSilt: Percent silt in soil PSD.

VisNeck: Understory density as measured by distance to visual obstruction at height of 1.5 m.

GrndCov: Ground cover by ocular estimate (0-3), where 3 is most dense.

GrzClass: Grazing pressure by ocular estimate (0-3), where 3 is most grazed.

BrnClass: Past fire frequency and intensity by ocular estimate (0-3), where 3 is most severe.

[b] Computations were by Canoco for Windows 4.5 (ter Braak and Smilauer 2002). After selection the 4 variables were entered together (not necessarily the same 4 for each group).

[c] Dates by group or survey method are given in Table 1.

[d] The group labeled MamHerp contains herptile and small mammal species. The group labeled Woody contains woody plant species.

for 3 groups (Table 20). Pine1 and Sand1 were nearly uncorrelated, so their effects were nearly additive (Table 21).

Comparing RDA with Logistic Regression

For stochastic reasons not all of a species distribution was explainable. Principal components analysis for each group of species (with cofactors where appropriate, but no factors) determined that the maximum percent of the variance explainable with 4 orthogonal axes was: ants (46.1%), beetles (34.4%), birds (42.3%), MamHerp (41.4%), spiders (39.4%), and woody (40.1%). Comparing these percentages with RDA (Table 21), the percent variance explained by the best 4 of 9 factors was poorest for ants, MamHerp, and spiders. It was better for birds and beetles, and best for woody plants.

Only the factors Pine1 and Sand1 were used in logistic regression, so comparisons with RDA were made only for those 2 factors (Table 21 with Tables 14–19 [footnotes]). Using the mean R^2 (converted to percent) as a measure of the variance explained for logistic regression, and the output of RDA, the variance explained for each group by RDA and logistic regression was, respectively: ants (8.7%, 15%); beetles (13.9%, 23%); birds (15.8%, 23%); MamHerp (9.9%, 17%); spiders (7.7%, 14%); woody (22.9%, 31%).

Conclusions and Relevance

Null hypothesis 1 was that species and species groups are not

Table 21. Redundancy analysis (RDA): For each species group the percent cummulative variance explained by the environmental variables[a] is given for Pine1 and Sand1, and for the first 4 constrained canonical species axes. Data were obtained from an east Texas upland forest study area during the period 1 March 1996 to 31 October 2002[b].

	Entered Individually		Entered together	Entered 4 together[c]			
Species[d] Group	Pine1 % variance explained	Sand1 % variance explained	Pine1 & Sand1 % cumulative variance explained	Species axis 1 % cumulative variance explained	Species axis 2 % cumulative variance explained	Species axis 3 % cumulative variance explained	Species axis 4 % cumulative variance explained
Ants	3.4	5.3	8.7	7.1	9.7	11.6	13.1
Beetles	8.3	5.6	13.9	8.5	14.6	17.0	19.0
Birds	13.2	2.5	15.8	13.6	16.5	18.7	20.2
MamHerp	6.7	3.2	9.9	7.3	10.9	14.2	15.2
Spiders	4.0	3.7	7.7	6.0	9.4	11.1	12.5
Woody	11.8	11.1	22.9	12.5	24.5	26.3	27.6

[a] Evironmental variables (factors) are defined as

Pine1: Dominant tree, categorical: Pine = 1, Post oak = 0.

Sand1: Soil texture (PSD), categorical: Sand1 = 1 if sand >70% (clay <9%), otherwise = 0.

all_BA: Basal area in m^2/ha for all tree species (trees < 25 cm DBH not included).

pcSilt: Percent silt in soil PSD.

VisNeck: Understory density as measured by distance to visual obstruction at height of 1.5 m.

GrndCov: Ground cover by ocular estimate (0-3), where 3 is most dense.

GrzClass: Grazing pressure by ocular estimate (0-3), where 3 is most grazed.

BrnClass: Past fire frequency and intensity by ocular estimate (0-3), where 3 is most severe.

[b] Dates by group or survey method are given in Table 1.

[c] Only the best 4 of the listed variables were used for each group (not necessarily the same 4)

[d] The group labeled MamHerp contains herptile and small mammal species. The group labeled Woody contains woody plant species.

associated with vegetation subdivisions. This hypothesis was rejected. The dichotomous vegetation variable dominant tree (Pine1) was significant ($P < 0.05$) for all 6 species groups investigated (Table 20). Some species groups are associated with some vegetation subdivisions.

Null hypothesis 2 was that species and species groups are not associated with the soil subdivisions. This hypothesis was rejected. The dichotomous soil variable subsoil texture (Sand1) was significant ($P < 0.05$) for 5 of the 6 species groups investigated. Some species groups are associated with some soil subdivisions (birds were not associated with soil in this study).

Null hypothesis 3 was that a classification based on soil does not have a higher degree of separation of species and species groups than does the classification based on vegetation. This hypothesis was accepted. Sand1 had a higher level of significance than Pine1 in only 1 of the 6 groups investigated. Dominant tree may generally have a higher degree of association with the distribution of species than does subsoil texture.

Null hypothesis 4 was that a classification based on soil does not augment the classification based on vegetation. This hypothesis was rejected. The variables Pine1 and Sand1 were nearly uncorrelated (Figs. 3–8). For 5 of the 6 species groups investigated the use of Sand1 with Pine1 improved the average explanatory power by nearly double (85%), but for 1 group (birds) the improvement was small (19%, Table 21). For some species groups the measurement and use of subsoil texture may improve the general ability to explain the distribution of species.

Separate from the null hypotheses is the question of meaning as it relates to application. The immediate objective of this study was to determine if the difference in species composition between a pine forest and a post oak forest (within the study area) was sufficient to warrant the separation into 2 vegetation formation subclasses as indicated by the criteria of UNESCO (1973). The conclusion is that the degree of difference did not warrant the separation into 2 formation subclasses. This conclusion is supported below.

Mueller-Dombois and Ellenberg (1974:228) suggest that a Jaccard index value between 0.25 and 0.50 is approximately the definition of a vegetation association, and that a value >0.50 generally indicates a similarity too great to be termed an association (they suggested *sub association* might be a better term). The Jaccard index was calculated for the 6 species groups investigated (Table 6). Only 1 group had a Jaccard index value <0.50 (beetles 0.34). The Jaccard index for woody plants was 0.61, which is particularly relevant because the Jaccard index was originally used for plants.

DISCUSSION

Interpretation of Graphs

It is useful first to explain the interpretation of Figures 2–8. The figures are graphs meant to display relative relationships, not exact measurements. Arrows and circles have defined meanings depending on the analysis procedure used, but often are used differently (as they are here) to show best visually the relationships. The first and second canonical axes were used for all the graph axes. These axes best show the factors of primary interest (dominant tree and the subsoil texture) because these factors were important in every group and nearly uncorrelated (hence the factors dominate different axes). Other rotations or pairs of axes could be used to better show the effect of other factors, but because these factors had less influence and were not the main factors studied, no other views are shown.

The angle between the arrows indicates the degree of correlation between factors. Examining Figure 8A (woody plants) it can be seen that Sand1 and pcSand are highly correlated, as are Pine1 and P_BA. Those factors at near right angles are nearly uncorrelated, as are pcClay and drought. The base (center point) of the arrows can be thought of as a center of the values for a factor, with positive correlations (associations) with species in the direction of the shown arrow, but just as important is an unseen arrow in the opposite direction indicating a negative correlation with species (the direction of correlation may be reversed if the values (levels) of a factor are defined differently [e.g., if the highest level of GrzClass indicated less grazing instead of more grazing]).

Factors with longer arrows have more overall influence (i.e., a general association with the distributions of species in the group examined). Species (circles) farther from the center are more influenced by the factors considered. The perpendicular projection of a species circle on a factor arrow indicates a stronger association when the projection is nearer the arrow point.

Examining Figure 5B (birds) it can be seen that bird species 20 and 26 are highly correlated with dominant tree (Pine1). The projection of bird 26 is farther up the arrow than bird 20, but bird 26 is farther from the arrow than bird 20. Examining the logistic regression for birds (Table 16) it can be seen that bird 20 has a Chi-square probability for dominant of 0.0005 and bird 26 a probability of 0.0001 indicating both have a similar strong association with (Pine1). Bird 21 has a high negative correlation with Pine1 (the unseen opposite arrow of Pine1) indicating it is associated with less pine and more post oak. On Table 16 this also is indicated by a strong association with dominant tree (P = 0.0007), but unlike in Figure 5B, the direction (sign) of the relationship is not known.

Examining Figure 8B again and it can be seen that species 27 and 36 both have a strong association with dominant tree (species 27 positive with post oak and species 36 positive with pine), and this also is indicated by Table 19. Species 59 has a strong association with soil (positive with sand, negative with clay or silt), and this also is indicated by Table 19. Species 23 has a strong association with soil (in this case a strong negative association with sand [the unseen opposite arrow of Sand1]), and this also is indicated by Table 19. Species 44 and 10 have a strong positive association with both pine and sand as indicated by their projections on the shown arrows Pine1 and Sand1, and by Table 19. Species 57 has a strong association with post oak and clay as indicated by the projection of species 57 on the unseen opposite arrows for Pine1 and Sand1, and by Table 19. Species 6, 11, and 26, near the center of Figure 8B have no association with any factor shown, and this also is indicated in Table 19.

Data and Analysis

Statistical power--There was no pre-survey attempt to obtain preliminary data and determine a standard deviation for the purpose of estimating the sample size needed. The number of plots in which different species would occur could not be known without an extensive sampling effort. Instead, for the main statistical procedures (RDA and logistic regression), only species were used that occurred in at least 5 plots. This minimum was chosen arbitrarily based on the general application of the binomial distribution.

For a given cell (e.g., pine-sand), the maximum count (occurrence) obtainable was 15. For a given binomial factor level (e.g., Pine1 = 1), the maximum occurrence obtainable was 30. According to the binomial distribution if the expected occurrence of a species (by the protocol used) was 5 in 15 plots for a cell, the species is unlikely to be zero in another cell by chance. If the expected occurrence is 5 in 30 plots for a binomial factor level, it is unlikely to be absent in the other level by chance. The expected occurrence of a species (given the protocol) is required for a binomial test but cannot be known. It is assumed arbitrarily to be 5 or greater for the number of plots examined. This assumption is not certain, but to a degree is forced by the constraint of a minimum count of 5. This count of 5 or greater could be obtained by chance from a smaller expected occurrence, but the sample count of 5 or greater is the most likely expected value based on the concept of maximum likelihood. This does not necessarily ensure adequate power for a single species, but does for a large number of species.

Generally the binomial distribution provides reliable tests for proportions between 0.20 and 0.80 (5/15 = 0.33 and 5/30 = 0.17). The arbitrary decision to use only species occurring in at least 5 plots allows the consideration of less common species or species that have restricted distributions. For uncommon but ubiquitous species, the information is less reliable (low but similar cell counts), but that information also reflects adequately the actual situation. For the species used, some were too common to provide discrimination and some were uncommon but too ubiquitous to provide discrimination, but over all species the number of occurrences provided good statistical power and appeared to reflect reality based on 25 years of field observations.

For the 60 plots inventoried, 229 species occurred in at least 5 plots (most in more plots and usually near optimum power). So 60 plots were more than adequate to provide reliable information on the distribution of species and certainly more reliable than 1 or a few dominants unless the distribution of most species is highly correlated with the distribution of dominants (i.e., that which is to be tested).

Presence or absence data--Generally continuous data are perceived as the best data, but this perception may not be true where parsimony and optimization are important, and for other reasons. In the conservation of species and populations, the overall distribution and occurrence of a species may be more fundamental and a better assessment of the viability than 1 or a few areas of high population numbers (i.e., a million plots each with 1 known occurrence of a species likely indicates a more secure species than a million individuals in 1 plot and none in the remainder). Also, there can be a false sense of accuracy with continuous data in many situations (Topping and Sunderland 1992, Fisher 1999). Estimates of the distance of birds from a point, and the number of individuals vocalizing can vary considerably among observers, but whether there was 1 bird of a species vocalizing or none may vary less among observers. Some assessments may be made more efficiently and at less cost with presence or absence data (e.g., the determination of male or female for a mammal may be more parsimonious with presence or absence data than with more expensive continuous data on height, weight, body fat, and proportions).

Presence or absence data are not necessarily categorical. The data are not continuous but can be quantitative or treated as continuous if data collection is designed for that purpose. The quantification comes from subplots within plots, or plots within cells or strata. The present study was designed in that manner so the data can be analyzed by plot or by cell (e.g., pine-sand). For each species the quantification comes not from the presence or absence (1 or 0) of a species in a plot, but from the number of plots the species was present within plots constituting a stratum. This allowed the Morista-Horn quantitative similarity index to be calculated, and facilitated the logistic regression and redundancy analyses.

The type of data collected should not be a product of personal philosophy, but based on careful consideration of true accuracy, efficiency, and optimization to meet the objective. For this study presence or absence data was most appropriate.

Percent variance explained--As a measure of the percent variance explained, the mean R^2 for logistic regression for each of the 6 species groups was consistently much higher (averaging approximately 60% higher) than the variance explained by the same 2 factors (Pine1 and Sand1) for RDA for the same 6 groups, respectively. I asked CANOCO spokesperson, Richard Furnas, about this difference and his opinion was that the logistic regression procedure by species was better optimized for each species, whereas the RDA and CCA procedures were analyzing all species in a group at the same time although each species potentially had a different distribution (e.g., linear, unimodal, bimodal).

Expectations of the percent variance explained by the broad factors used were not high for any group. Each species responds to many factors including: surroundings, history of surroundings, spatial relationships, recent seasonal weather, climate over the last several years, and the influence of these factors on the populations of competitors, predators, parasites, and diseases; and the interaction of all these factors and more. This variation is generally lumped as stochastic because it is not explainable if these variables are not measured and included in the analysis.

Additionally the plot size used has a major effect on the percent variance explained. Consider a common animal species that always occurs in a given ecological type (e.g., pine-sand) and never in any other ecological type. If the plot is too small relative to the home range of the species, the species may rarely or never be encountered in a plot within the survey period. Similarly if the species is rare, or travels only a small distance per day, it may rarely or never be encountered during the survey period. The species may occur in a subassociation within the ecological association investigated and a given set of small plots may rarely include that subassociation. If the plot is too large and cannot be completely surveyed with intensive effort the species may not be encountered. Generally active and easily encountered species, with home ranges not orders of magnitude different than the plot size, have the highest percent variance explained if the species is discriminating of the factors used. Species with low percent variance explained may be ubiquitous relative to the factors used, or poorly matched to plot size, or difficult to survey accurately for a variety of reasons (e.g., activity sensitive to weather, short life span, boom and bust populations, or rarely detectable).

Despite all these difficulties, the percent variance explained by 4 factors indicates a likely mapping utility for some factors for some groups (Table 21). The percent variance explained by the 2 main factors (Pine1 and Sand1) indicates a likely mapping utility for some species (Tables 14–19).

Plot size--The 1-ha plot size pertained exactly only to plants. This plot size (in conjunction with the 8 hours of survey time) also applied well to birds in general where the objective was to determine with a high degree of certainty whether a vegetation type was used by a bird species during the breeding season (as opposed to a low degree of certainty for small plot surveys of only a few minutes duration). The plot size was not appropriate for a few bird species, notably hawks (*Accipitridae*) and vultures (*Cathartidae*).

The plot size probably applied well to small mammals caught in Sherman-trap arrays, but did not apply to small mammals, herptiles, or invertebrates caught in herp arrays because these arrays were only at the center of the plot. In retrospect it might have been more optimal to have 3 arrays with 1 5-m drift fence (e.g., 30 m from center on 120° rays) than the configuration used. Also it would likely be more optimal to use pitfalls separate from drift fences because large snakes cross at the bucket. An optimal design might be 4–8 pitfalls of 15.2-cm-diameter polyvinyl-chloride (PVC) pipe in a widely-spaced (but within plot) array without drift fences. This diameter is posthole size and would be much easier to dig with less disturbance and greater coverage. It also would facilitate a within plot variance if needed.

In general the plot survey procedures were not designed to obtain within plot variances because these variances were not needed for the statistical procedures used or the findings (but within plot variance could be calculated for some factors). Random samples of sets of 5 plots within the cells of 15 could be done post survey for variance within cells but was not necessary.

Species accumulation curves--A major concern in the conservation of biodiversity is determining sound estimates of the number and kinds of species in proposed large-area units that potentially could provide maximum complementarity with other such units. Obtaining information on all species for many such areas would be cost prohibitive (if possible). One approach is to use arbitrary stopping rules whereby the number of new species expected to be found in new samples is small, and then projecting to the total number of species based on the near asymptote of the curve generated for the decreasing number of new species in the ordered and completed sampling units (Colwell 2004). This is a useful approach but not satisfying in some ways.

One problem with the above approach is the curves increase indefinitely and it is not certain the extrapolated shape of the curves is predictable from the data. There does not appear to be a solution to this problem and the assumption of the overall shape of the curve has to be made. Given this assumption, 2 pressing problems remain: (1) The species and species groups chosen for inventory affect the estimate, and (2) the ecological and biogeographic knowledge of the investigators affects the results (Kerr 1997, Alonso 2000, Lindenmayer et al. 2000).

Environmental variables used--Of the 16 factors initially used in the analysis, 7 were subsequently dropped. Five of these were dropped because they were redundant (highly correlated with included factors) and less explanatory. Two of the factors, drought and precipitation (Table 2 footnotes) were highly correlated with included factors, but also as much or more explanatory. These 2 factors were dropped because they are not usually available at the pixel level of most efforts to map ecological associations. The 2 factors were initially included as a matter of general interest because they were suspected of being the main controlling factors for the distribution of species and as such would be the factors for which vegetation mapping was a surrogate. This appeared to be the case for the factors investigated because drought had a higher association with the distribution of species than any other factor. Precipitation also was highly associated with the distribution of species but less so than drought. This finding is consistent with the hypothesis that extremes are more important than means because extirpations require more time to recover.

Besides the factors of primary interest (dominant [Pine1] and soil

[Sand1]), other factors were included because of common use with species groups (e.g., basal area and understory density with birds) or because of common management interest (burning, grazing, creating openings). Two of these factors, burning and grazing, were moderately correlated with either Pine1 or Sand1 but were included anyway and had a small but potentially useful association with some species. The measure of understory density (visibility at near human eye height) was not highly correlated with any factor and had a modest and potentially useful association with some species.

Two of the dropped factors, groundcover and visibility at approximately knee level were correlated with each other, and had little association with the distributions of most species in this study. Perhaps a logarithmic scale of estimated ground cover, e.g., suggested by the Ecological Society of America Vegetation Classification Panel (2004:40 electronic [not cited]) would have provided a better separation of species. But, I am skeptical of: (1) my ability and that of others to provide repeatable estimates in widely separated areas, and (2) the parsimony of such data in predicting the occurrence of groups of species and adding substantially to the ability to map large, unvisited areas of vegetation. I have similar concerns with the estimation of canopy stratification, but it is more likely an important factor that needs to be measured or reliably estimated in a parsimonious and optimized way.

The reason for the inclusion of subsoil texture as a factor warrants explanation. The basic reason was to examine the possibilities of soil as an indicator of the basic general factor *moisture*, and if important to consider ways to map a factor, soil moisture, not by soil maps, but with remote sensing.

Previously (Yantis 1991), I examined the association of surface soil texture and chemistry with the distribution of 37 forbs in 227 plots in a 100 km X 150 km study area. This previous study concluded that percent clay and percent sand were important mapping variables, but did not find silt to be so. Daubenmire (1968*b*) and Hinesley (1986) found soil depth to be an important variable influencing the growth and distribution of vegetation.

Prior to the present study I had the opportunity to work with soil scientists for several months mapping counties in and around my study area. Their work involved taking core samples to a depth of 1–2 m. We examined the soils and I attempted to relate the soil texture and profile to the surrounding native vegetation community. I concluded, subjectively, that the texture of the subsoil was an important factor in the distribution of plant species (likely because of the differences in soil moisture holding capacity), and that the texture at a depth of approximately 30 cm seemed to be most influential in the counties we were working (hence the depth of 25–35 cm examined in the present study).

An argument could be made for the use of the upper few cm as important because plants germinate in that layer, but it seemed to me that over time through competition the moisture relations of the subsoil determined the community. In a study in Idaho, Daubenmire (1968b) found that in August the soil moisture at the 30–50 cm depth "showed the most consistent differences among habitats".

Contrary to the previous study (Yantis 1991), the present study found percent silt to be an important factor. A plausible explanation for the contradiction is that the first study was on the surface soil where the infiltration rate is largely influenced by the percentages of sand and clay. The present study examines the subsoil where silt is an important factor in holding soil moisture, (and thereby likely influencing the growth and survival of plants, and possibly in part the distribution of plants).

Background and Context

This section is independent of the present study and findings. I believe it is important to provide the broad general setting that motivated me to conduct the present study. This background and context should facilitate understanding the place, and possible utility, of the present study within the broader context of the conservation of biodiversity. Wiens (1997) wrote that a scientist should: "distinguish clearly between statements that are based on science and those that are based on personal values or viewpoints" The information in this section should generally be construed as opinion.

My opinions are based on discussions with conservationists at many professional meetings during the early 1970s, and on my daily job since then in forest and field investigating factors influencing the distribution of species, and mapping distributions of species. Although I take full responsibility for any flawed opinions, I do not imply the opinions are mine alone or originated only with me. My thoughts and interpretations must have been influenced by other sources. Most likely sources include: Kuchler (1967), Daubenmire (1968a), Whittaker (1973*c*), and Mueller-Dombois and Ellenberg (1974). I relied most directly on Holdridge (1967), and found that publication more useful than Holdridge (1947) which is cited more often.

Concerning an approach to conservation bandied about in the early 1970s, and that I put forward here in my own way, perhaps the most similar approach is that of Noss (1983), or Pressey et al. (1993). Where I rely on specific published information to augment or clarify the approach I put forward here, the author of that information is cited in the text. This section continues from here to the subtitle Example.

Primal ecosystem management--The current definition of ecosystem management is not the one used herein. In the early 1970s some wildlife conservationists considered ecosystem management, in common parlance, to have the primary objective of conserving all native species in each biogeographic region. The common and appropriate size for an ecosystem was considered to be the size necessary for a secure population of a large top-level predator (e.g., mountain lion [*Felis concolor*]), or about 2,000 individuals. This size area was generally believed to be both necessary and adequate to conserve all other species, known and unknown, in a biogeographic region.

The strategy was not to exclude the exploitation of resources, but rather to exploit in a way that mimicked the natural processes under which the natural species evolved, and to maintain reasonably similar vegetation structure and species composition. One objective was to obtain no data on rare species, and only the minimum data needed to ensure compliance with the general structure and composition limits. This strategy was considered most likely to succeed in conserving the most species, especially all the unknown species, with minimum overhead. The strategy was to remove the focus on endangered species, and to place the focus entirely on habitat. The strategy recognized that some species would be lost without intensive, specific management, and this was considered an acceptable trade-off for the efficient conservation of so many species.

The mostly untested strategy of the primal ecosystem management concept was not meant to be applied everywhere, but only to large areas purposely selected for the conservation of biodiversity in each biogeographic region. With the increasing and broadening interest in ecosystem management the meaning of the term eventually shifted to what was earlier called holistic resource management, and left the primal version of ecosystem management as a concept without a name. The rational and premises of primal ecosystem management follow.

Given the assumption that society wants to conserve biodiversity in its fullest sense, a strategy should to be promulgated that will meet that objective if implemented (Groves et al. 2002). Conservation efforts are often directed at increasing public awareness and political support (e.g., backyard habitat, or hummingbird watches). These activities are not without the benefits of increasing the enjoyment of life for many people, and as such are useful programs for wildlife conservationists to promote. Other conservation efforts are often directed at conserving single species (e.g., artificial nest boxes for the red-cocked woodpecker [*Picoides borealis*] and the elimination or exclusion of predators, parasites, diseases, and competitors). These efforts too have merit. But many professional conservationists believe that these efforts are not going to ensure the conservation of the millions of species at risk.

Many professional conservationists believe a system of large refuges and large connecting corridors must be established if millions of species, many unknown, are going to be conserved (Noss 1993, Noss 1996, Gurd et al. 2001, Schonewald 2003). Some semblance of a strategy must be promulgated that contains the following salient features:

(1) The scope of the strategy is worldwide and for all species, but recognizes the need for each country and biogeographic region to focus on internal needs so as to increase the likelihood of overall success and the conservation of a wide variety of life forms and natural habitats (Olson and Dinerstein 1998, Groves et al. 2002).

(2) Although Olson and Dinerstein (1998) and Groves et al. (2002) recognize the need for immediate action, there is little discussion as to the life of the strategy and goals. In my opinion the appropriate scope of time for the life of the strategy and goals is about 2,000 years (i.e., the salient question for any

conservation project should be, where do we want to be in 2,000 years?). This seems absurd on its face, but upon reflection what sense would strategies and goals make for conservation with a time frame of less than 2,000 years? Conservation is a completely altruistic endeavor and meant to leave the world in the most enjoyable condition for all kinds of people. The lead time of 2,000 years is only the connected life times of 40 people, and I think we have a reasonable idea of the consequences of our decisions over that time frame.

(3) Biogeographic regions are fundamental to the strategy (Groves et al. 2002). Each region is defined by a general regional climate (Groves et al. 2002), and the major barriers that impede the flow of species among regions (McLaughlin 1992, Cox and Moore 1993, Fairbanks et al. 2001).

(4) Within each biogeographic region a preserve (ecosystem in early parlance) should be selected, if feasible, with the prime objective of conserving biodiversity for the region. The size of this preserve generally should be not less than a million hectares (Noss 1993, Noss 1996, Gurd et al. 2001, Schonewald 2003). If the biogeographic region is large and somewhat diverse, more than 1 preserve may be needed to conserve the biodiversity of the region.

(5) A million hectares alone is not enough to conserve biodiversity. Each preserve generally needs to be connected to other preserves by corridors approximately 5 km in width (Harrison 1992). Alternatively or in conjunction the area of land (matrix) between preserves may be managed so as not to exclude the movement of most species although the matrix may be managed for other

objectives and not ideal habitat for many native species (Rodenberg et al. 1997).

(6) Because the prime objective is the conservation of biodiversity, any management must not interfere with natural processes, overall vegetation structure, and general species composition. Although promoting natural *per se* is a reasonable objective, the reason for insisting on natural processes is because the species present evolved with these processes. Because the species present cannot be known or managed individually, the most parsimonious and optimized strategy is to keep the preserve natural (i.e., based on the last few thousand years before industrialization, but evolving slowly). The concept and strategy expressed in this paragraph may be the most fundamental and important for the conservation of biodiversity. This strategy does not exclude substantial exploitation if the exploitation is within the guidelines and does not conflict with the prime objective.

(7) The concept of biodiversity is often misconstrued. High alpha and beta diversity in an ecosystem do not equate to the conservation of biodiversity, and in fact are often indicators of declining biodiversity. Increases in local biodiversity often result from a breakdown in the natural processes and changes in the overall vegetation structure and species composition (usually as result of man's activities). These changes often introduce many new species and drastically change the composition of existing species. This results in the extirpation or extinction of a few species but a substantial increase in species already common elsewhere. The net result is a loss of true biodiversity (e.g.,

global number of species).

(8) The concept of complementarity is important in conserving biodiversity. The high diversity of an area, whether a product of man or natural processes, is not necessarily the most important criteria in selecting a preserve to conserve biodiversity. The most important concern is that a system of preserves across a continent or subcontinent conserves the highest diversity with the highest level of security. This approach requires each preserve to complement the others. Two large-area units may each have high diversity but combined do not include more species. Conversely 2 large-area units may have modest or low diversity but combined include many species.

(9) The efficient ability to select the most parsimonious and optimized system of preserves depends entirely on the ability to define accurately and to map accurately the most basic and appropriate unit of classification of species groups (species associations or ecological associations). For the purpose of the conservation of biodiversity (including plants) the species association is the same as the vegetation association. This synonymy is because, for the purpose of conserving biodiversity, vegetation cannot be mapped adequately without using the basic environmental variables or their surrogates and without using the concepts of biogeography (particularly barriers and corridors). When these basic variables and concepts are used, the vegetation association becomes an ecological unit that has the best expectation of predicting the species composition for all species, including plants.

Alternative strategies--Goldstein (1999) and Martin and McComb (2003) seem to disagree with parts of the primal ecosystem management strategy, in particular the de-emphasis of species management and the emphasis on natural conditions and processes. I will not make a strong rebuttal because the emphasis of this study is on mapping, and because I agree with them that ecosystem management as currently practiced is not conducive to conserving true biodiversity.

Using a set of species instead of a set of conditions as indicators of success or failure simply shifts the umbrella unless every 1 of thousands of microscopic species is monitored. Using species encourages species management (e.g., removing cowbirds, constructing nest boxes) and similar or worse activities to ensure the target (umbrella) species do not decline while the ecosystem is exploited and other unknown species are extirpated. Target species may be purposely increased with apparently no thought of the consequences for their unknown prey species and competitors (Simberloff 1997).

Based on past experiences, I do not have confidence in the ability of biologists to pick sets of species that will serve as an umbrella for all species, or to manage those species to benefit all unknown species at risk. I suppose others do not have confidence in the ability of biologists to pick natural habitats and processes and to ensure those are protected and managed for the benefit of all unknown species at risk. I am in the camp favoring natural habitats and processes, but either approach should work if the areas are very large, well connected, and the exploitation is small and gentle.

Present study--The utility of the findings of the present study are expected to relate to the strategy of primal ecosystem management by: (1) improving the relevance of data and the optimization of acquiring data, (2) improving maps for locating the best areas and boundaries of areas that have high complementarity, and (3) improving the nomenclature of associations to allow quicker and better understanding of differences among associations and among biogeographic regions.

Investigator bias and variation--Vegetation can interfere with mapping vegetation by remote sensing for many purposes. The dominant vegetation can prevent the remaining vegetation from being accessed and incorporated. For a site visit (ground-truthing) bias can be introduced because the investigator has a preconceived notion that the dominant species strongly influence the occurrence of most species (Renkonen 1949, Groves et al. 2002). If the vegetation is defined by dominants, and measured by dominance, then dominants will be most important and characterize the site by definition. Rarely is the dominant species treated as any other species (i.e., simply occurring on a site in response to many of the same factors that influenced the other species to be there).

Regarding dominant species, 2 concepts should be kept carefully separated: (1) The dominant species has influence, or (2) the structure of the dominant species has influence. The latter is an important variable (e.g., forest), but the species making that variable may be interchangeable (i.e., different dominant species for the same vegetation association, as was the case for the present study).

Bias can be introduced because of preconceived notions about the importance of differences in the appearance of vegetation or differences in color on an image from high altitude. Differences in overall gross vegetation structure (herein this phrase always means vegetation formation class, e.g., forest, scrub, or herbaceous) generally indicate substantial differences in species composition. Within a gross vegetation structure differences in species, color, or minor structure should be treated skeptically as indicators of differences in species composition unless corroborating evidence of substantial differences in important abiotic factors are observed (or the species composition is empirically determined).

Regarding sampling and selection of species groups, if an investigator understands correctly all the major vertical and horizontal structural components that influence the local (a million hectares) distributions of species, and all the major biogeographic factors that influence the complementarity of species among large-area units throughout a biogeographic region (20 million–50 million hectares), and the role of recent (a few thousand years) co-evolution of species and natural vegetation, then that investigator is able to stratify the sampling and select the species groups to optimize the number of species observed within a large-area unit and the complementarity of the findings among large-area units.

An investigator, not as knowledgeable, will not stratify optimally or select species groups optimally and likely will estimate less or different biodiversity for the same sampling effort. More important, the comparability and complementarity among large-area units will be less certain (comparability here means if the estimate of biodiversity for area A < area B < area C, then that relationship will hold regardless of the investigator planning and conducting the inventory, although the estimate of total biodiversity may be different for each investigator).

Species groups and habitat structure--Examination of Tables 14–19 and Figures 3–8 indicates: (1) species respond individualistically and not by taxonomic group, and (2) different sets of species would predict different estimates of total species and different degrees of complementarity among large-area units. It is important to select a set of species that best extrapolates to true biodiversity (i.e., for comparisons [the actual biodiversity can never be known]), and also best serves as a reliable surrogate for assessing complementarity. It is important the selected set be the most parsimonious set.

A miscellaneous set of taxonomic groups does not seem to be the answer. A hint of the answer may be in the fact that in the present study birds were the only group strongly associated with the basal area of all trees combined. In this study birds were the only group that could reasonably be expected to respond strongly to canopy cover and vertical structuring (correlated with basal area, though imperfectly). Other groups had species that lived in the canopy, but these canopy species for the most part would not be encountered by the survey methods used. Trees make up the canopy, but vegetation germinates and is rooted in the ground. The distribution of tree species is likely not as directly related to canopy cover and vertical stratification as is the distribution of bird species.

Differences in habitat structure were associated with the considerable difference in species composition between the east Texas forest and the south Texas shrubland in this study. The suggestion is that vertical and horizontal structure are important factors in determining the diversity and complementarity of large-area units (contingent upon the constraints of biogeography). Examples of components of horizontal structure as used herein include characteristics of topographic relief, soils, rocks, ledges, logs, and patchiness. Examples of components of vertical structure include vegetation height, layering, leaf and stem characteristics, basal area, and snags.

Selecting species groups--If vertical and horizontal structure are important influences on species diversity and the complementarity among large-area units, then it is reasonable to purposely include species that evaluate or reflect the influence of the structural components. This approach means allowing for and verifying the expected increase in diversity as a result of each structural component known or thought to be important. The approach means selecting the species with care and forethought. Kremen et al. (1993), Kerr (1997), and Alonso (2000) have made similar suggestions, but not necessarily with the same focus as discussed below.

The consequences of randomly choosing species from a list of all species would likely be a list dominated by beetles. The beetles could be dominated by a few families or groups. The groups could be associated with 1 or a few structural components. The estimate of biodiversity by extrapolation would likely be low or uncertain. A list of all species would contain mostly species not in the biogeographic area of interest. A list of species within a biogeographic area of interest would not contain many of the species occurring in the area because many species are unknown . For many species that are known their distributions are not known well enough to predict with confidence their occurrence within a few thousand square kilometers. The distributions of vertebrates generally are well known, although some in the present study were beyond their known range (i.e., not expected). About 30 % of the spiders and beetles were unknown or not expected. It seems likely a high percentage of species of microscopic organisms would be unknown or not expected.

Many randomly chosen species might be difficult to observe or identify. In addition to the constraint that the chosen set of species be adequate to evaluate (reflect) overall habitat diversity, the species should be easily observed and identified. There is no reason to believe that difficult to observe and difficult to identify species provide better indicators of habitat diversity. Rare species might, but are not appropriate species for a coarse-filter approach.

The investigator will intentionally or unintentionally choose the species to be used. It would be best to choose the species wisely. The process should include the concepts of biogeography and an assessment of vertical and horizontal structure as discussed above and later. In the present study, 550 species were used for the similarity indices and 229 for the evaluation of factors by RDA and logistic regression. In retrospect, more efficient choices of species groups and less species could have been used and better results obtained. With wise choices, 100–500 species likely would be adequate to sample efficiently all spatial variation over a wide area (20 million–50 million hectares). This number of species should provide adequate information to generate species accumulation curves to obtain the relative maximum number of species, and to provide subsets of species that characterize large-area units and provide the needed measures of complementarity.

The inclusion of carefully chosen groups to reflect each structural component (e.g., birds with canopy layers) does not preclude reflecting the influence of unknown habitat components. Within any group are many species that do not reflect the general requirements of the group (Tables 14–19, and Figs. 3–8). If several groups are selected to reflect several structural components, many species will reflect a wide variety of habitat components. But choosing groups carefully ensures the obvious habitat components will be reflected and the inventories will be efficient and optimized.

Invertebrates and alternatives--In the past few decades there has been increasing interest in using selected invertebrate groups for assessing biodiversity and complementarity (Renkonen 1949, Majer and Beeston 1996, Oliver and Beattie 1996, Longino and Colwell 1997, Fisher 1999, Alonso 2000). Invertebrates were used in the present study. Obvious problems with using invertebrates include: (1) populations of many species are short lived, or vary greatly with short-term differences in weather, or among years, (2) many species are difficult to catch or identify, and (3) regardless of the attempted thoroughness of an invertebrate inventory, there are usually many species collected only once in a large number of plots or survey units.

Invertebrates can be used in the same way as any other group of species. A set of invertebrate species needs to be selected that will assess a major component of habitat structure (e.g., logs or canopy layering). The species in the set must be long-lived and reasonably stable over long periods of changing weather and years, and easy to observe and identify. Conceivably different sets of invertebrates could be used for all of the different components of habitat structure, or a combination of sets of invertebrate and vertebrate groups could be used to assess different components of habitat structure, but all need to conform to the basic requirements: (1) each species group has clear and parsimonious utility, and (2) each species used is easy to observe and identify.

The differences in the efficiency of species groups are considerable. In the temperate zone all species of birds and woody plants can be fully inventoried and identified to species on a 1-ha plot in 1 day (not including the time spent in selecting, locating, and accessing the plot). For herptiles several weeks are required to inventory fully all species with the same level of confidence as for birds and woody plants.

Invertebrates are useful for investigating the response to disturbance and for many other objectives (Kremen 1993). The objective of biodiversity surveys is not to find as many species as possible, or to reflect every habitat component no matter how minor. All estimates of biodiversity are incorrect (Colwell and Coddington 1994). The objective is to have species that parsimoniously and efficiently serve as surrogates to faithfully represent overall biodiversity so that different areas can be compared with confidence. Invertebrates may reflect fine structural differences (Stratton et al. 1979), but vertebrates may investigate, feed in, and also reflect those differences. More side by side comparisons are needed among species groups to see which groups most parsimoniously and efficiently provide consistent relative estimates of the biodiversity among different areas.

Selection of species groups should not be a matter of personal philosophy or expertise, but rather based on a careful evaluation of each structural component within a biogeographic region and then a careful determination of the optimum sets of species needed. Within a biogeographic region the same groups of known species should be used throughout for comparability. Oliver and Beattie (1996), and Longino and Colwell (1997) suggested the use of morphospecies. The need for comparability makes the use of morphospecies questionable unless it is known that species A is species

A throughout the biogeographic region. Otherwise complementarity cannot be determined and the comparison of large-area units cannot be done.

In different biogeographic regions different groups of species likely will be chosen, possibly with no species in common among regions. Among biogeographic regions determining complementarity is less important. If the boundaries of biogeographic regions are determined properly then high complementarity among all biogeographic regions is expected a priori. Obtaining at least 1 preserve in each biogeographic area is a high priority in order to maximize complementarity and the efficient conservation of biodiversity, and should generally take precedence over concerns among biogeographic regions.

Delimiting biogeographic regions-- The terms bioregion, ecoregion, and biogeographic (or biogeographical) region are sometimes used interchangeably and for any size. Herein I use the term biogeographic region to emphasize the use of the concepts of biogeography (particularly barriers and corridors). For most strategic conservation planning a biogeographic region is generally on the order of 20 million–50 million ha, sometimes less or much more. Ricketts et al. (1999) mapped the ecoregions of the lower 48 states of the USA. One of the smallest ecoregions (in central Texas) was approximately 5 million ha. One of the largest (in the northern plains) was approximately 60 million ha. Major natural barriers that impeded the exchange of species in millennia and centuries past (and may remain today) can be important in determining true biogeographic regions (i.e., regions with a natural, relatively unique complement of species) (McLaughlin 1992. Cox and Moore 1993, Forman 1995). These barriers and the contained regions are best determined using large-area topographic maps in conjunction with a vegetation map of the world (e.g., Global 2000 Landcover [Joint Research Centre 2000]) and a climate map of the world (e.g., Litynski [1984]). Geology maps also are useful.

Major barriers are usually long linear features such as mountain ranges or large rivers (e.g., the Mississippi River) often in conjunction with a continuum of climate change that is accentuated at the barrier. Gradual change over long distances with no distinct boundary is a common problem. In such a case a broad (e.g., 100-km width) ecotone should be named, preferably centered on the best minor boundary that can be found.

A biogeographic region is not expected to be uniform and may be far from uniform (e.g., containing mountains, basins, rivers, and lakes). Because species movement is impeded among biogeographic regions, a corollary to the description of biogeographic regions is that the same ecological sites (herein meaning sites with the same abiotic factors [an ecotope]) in different regions have few or no species in common.

For example, consider 2 ecological sites with the same soil, elevation, slope, slope aspect, topographic position, vegetation formation class (a surrogate for precipitation), and grossly similar surroundings (i.e., not comparing an isolated 1-ha woodlot with 1 ha in the interior of a large forest). If 1 of these ecological sites is in a different biogeographic region than the other, then the 2 ecological sites should have few or no species in common. Conversely, if 2 very different ecological sites are in the same biogeographic region, they may have many species in common. In general different ecological sites in the same biogeographic region have species in common.

Different biogeographic regions may have no ecological sites in common (e.g., mountainous regions versus flat coastal regions). Some large areas within a biogeographic region may have no ecological sites in common and few species in common (e.g., large areas of limestone abutting large areas of sandstone). These can be called biogeographic subregions. The key difference, aside from size, is that these subregions usually form a mosaic such that similar vegetation associations can be found scattered in different areas of the biogeographic region.

Barriers, geology, and soils--The importance of barriers and corridors has been mentioned. A barrier for 1 species can be a corridor for another and visa versa (e.g., a long, linear mountain range can be a barrier to many lowland species, but a corridor for many montane species). Most barriers are only partial barriers and act as a filter that limits the kinds of species that can cross (Forman 1995). Geologic formations are common partial boundaries. Geologic formations may be igneous, sedimentary, limestone, sandstone, marl, or other types based on the original source and mode of deposition. Geologic formations are not uniform, but usually have certain basic characteristics and repeating patterns. Geologic formations may have overall features such as elevation and topography that influence the distribution of species. Geologic formations develop characteristic types of soils and soil patterns that influence the distribution of species.

The reason that geologic formations and soils have relatively abrupt boundaries is often because of where the lava or water or other agent of transport stopped abruptly long ago. Deposits that formed on the ocean floor may be uplifted and broken over time. The point is that for various reasons geologic formations (here includes resulting topography) and soils often have relatively abrupt boundaries compared to climate (Whittaker 1973*b*, Davis and Goetz 1990, Anderson et al. 1998).

The characteristics of geologic formations and soils are the main reasons why vegetation has real and relatively sharp boundaries, rather than being continuous as Whittaker (1962) found for a smooth environmental gradient up a mountain slope (Whittaker was well aware that geology and soils could cause sharp boundaries). Different geologic formations and soils may have different chemical composition, and in the extreme this can be the reason for differences in plant species on different soils. But the primary reason for the differences in plant species on different soils is because of the difference in water holding capacity as a result of differences in soil depth and in percent clay and silt in the subsoil. The water holding capacity of soils and the soil chemical properties are often strongly correlated.

Primary factors and surrogates--Of the 3 primary factors affecting the distribution of plants (temperature, moisture, and insolation), soils relate directly to moisture (moisture as used herein includes the terms water, humidity, precipitation, condensation [dew], and evapotranspiration). Climate and topographic position also relate to moisture. The 3 primary factors are correlated, and often 1 can be predicted from the other 2. But the prediction can sometimes be poor. In mapping it is best to include each primary factor.

Factors used in defining and mapping associations for the purpose of conservation of biodiversity are usually surrogates for the primary factors. The primary factors usually cannot be mapped directly. In many situations the vertical and horizontal complexity is such that several inter-correlated surrogates are needed to characterize adequately the associations and map them.

Primary factors and commonly correlated surrogates (in parentheses) for each are: (1) temperature (elevation, slope aspect, latitude, and vegetation structure), (2) moisture (slope, topographic position, soil, and vegetation structure, and (3) insolation (slope aspect, latitude, and vegetation structure). All of these are called factors, and except for latitude, may have abrupt boundaries and be strongly influential at the site or local level. Latitude can be important for characterizing and naming otherwise similar sites at different latitudes. Regional and local climate can be important for a site characterization, but may not be known or adequately applicable for a given site. Holdridge life zones (Holdridge 1947, 1967) are conceptually useful and can have application at the site level.

The climate map by Litynski (1984) is useful in conjunction with major barriers as noted earlier in the discussion on biogeographic regions

It is widely recognized that the use of environmental variables can assist in mapping vegetation for some purposes (The Nature Conservancy 1998, Manis et al. 2001). Without now entering into the controversy of mapping potential or existing vegetation, it would seem nearly all uses of vegetation mapping would benefit from the use of environmental variables to improve classification accuracy. The name of a vegetation association at 1 point in time does not provide much information. Often a map is not current and some reasonable expectation of conditions 5–10 years later would be helpful. The environmental variables can help make a more accurate prediction. Also much simple information (e.g., site index, slope, topographic position, and other factors mentioned under mapping factors above) would be helpful in management applications and in predicting the occurrence of species not in the vegetation descriptions.

Methods used in vegetation mapping for the conservation of biodiversity should be based on remote sensing (herein including the thematic mapper, the digital elevation model, and other reliable models). Factors should not be used that cannot be measured or reliably estimated by remote sensing. A different approach likely would not be parsimonious or optimized. Ground measurements are too expensive and have limited application for the large areas to be mapped for the conservation of biodiversity. Other approaches using physical factors, (e.g., Barnes et al. 1982), do not focus on the primary factors or their surrogates, and do not stress remote sensing. These approaches are different than the approach described herein.

In general mapping by remote sensing should be adequate, but sophistication is required. Remote discrimination of similar forests that have differences below the canopy in vertical or horizontal structure can be difficult to differentiate (i.e., one cannot see the forest for the trees). These differences can make a meaningful difference in the species composition. On a regional basis it is likely that discriminating spectral response patterns can be found for the below-canopy discriminations and the few other difficult but important discriminations (but at considerably more expense than for most of the needed discriminations).

Transformations and mathematical equations (e.g., Holdridge 1967, Manis et al. 2001) should be used when helpful in relating factors to associations that separate species into distinct groups. A time series of satellite imagery (Di Paolo and Hall 1983, Azzali and Menenti 2000, Manis 2001) can be helpful in extracting information on important factors not readily measured (e.g., subsoil moisture or texture). Much smaller pixels (<100m resolution) need to be used than Azzali and Menenti (2000) used (approximately 4 km resolution), but the rationale for using time series is the same.

Because the human eye can differentiate easily only a few hundred colors, vegetation for a moderate sized area (e.g., 100,000 km^2) is generally classified into at most a few hundred associations (often much less) for mapping purposes. But it can be useful to maintain information on a thousand or more finely divided associations. Although much information at the level of these associations is not of additional consequence, the opportunity should not be lost. If an investigator is standing next to an item of interest (e.g., a particular flower, lizard, or bird nest), the precise location should be determined with a geographic positioning system and directly associated with the fine-level classifications in a geographic information system (or compatible file). If the number of such relationships increases over many years to a useful amount, then some important feature may be identified or the associations refined.

Animal associations--Animals in general seem difficult to fit into vegetation associations. To some extent this is a misconception because highly mobile and observable animals (e.g. birds and large animals) readily are noticed in marginal or rarely used habitat types. But sessil, stationary plants often are not noticed when occurring in rarely used habitat types.

Scott et al. (1993) provided an overview of efforts and difficulties in defining associations for animals. O'Neil et al. (1995) discussed relating animal associations to vegetation associations and demonstrate a method. Edwards et al. (1996) also discussed relating animal associations to vegetation associations and demonstrate a different method. Beard et al. (1999) used vegetation and also climate and spatial correlation to determine statistical probabilities for species occurrence. The topics covered in the 4 papers above fall generally in the category of coarse vegetation classification. I add the following comments based on the findings of Whittaker (1952, 1962) and on the related findings of my study.

Species are distributed independently over a uniform area. A relatively abrupt (steep) change in the primary factors (temperature, moisture, and insolation) or their surrogates (particularly soil moisture and overall gross vegetation structure) cause boundaries for many species and consequently different associations on either side of the boundary. Although these boundaries are usually obvious, difficulties arise because there are many obvious changes that are not necessarily boundaries (e.g., different colors on a satellite image, or on the ground a different aspect of vegetation or kinds of plant species). Visual boundaries should not be used in the absence of a compelling reason based on physical factors (e.g., substantial differences in soil or overall gross vegetation structure [the latter is a surrogate for internal changes in temperature, moisture, and insolation]). The key to determining associations is in being able to differentiate between real boundaries and pseudo-boundaries that do not differ in species composition on either side. These false boundaries are likely an important cause for some of the difficulties in mapping plant and animal species.

To this point in the discussion there is no difference in determining animal or vegetation associations. But animals move. This movement is their evolutionary advantage and is often specifically directed at using different associations. This situation does not mean an animal species is not a valid part of a valid vegetation association, but it does mean an animal species usually also is part of another vegetation association, and often all of the associations in a general area. This can also be true for a plant species, but not usually as often and not usually with all of the associations in a general area.

The fact that animals move means it is necessary to consider the spatial relationships of vegetation associations. The most salient point in mapping animals is that these vegetation associations must be known first and they must be valid (i.e., must be based on the primary physical factors as well as the vegetation, and could legitimately be termed ecological associations).

The first step in determining valid associations is to: (1) determine elevation and latitude for temperature, (2) determine slope for moisture, (3) determine aspect for insolation, (4) determine topographic position for areas of low relief (i.e., if mesa or floodplain), and (5) determine soil moisture holding capacity using the best infrared band and appropriate time series satellite scenes (this is especially needed in biogeographic regions not dominated by mountains). These results may be combined in various ways as components, but should be either interval or categorical data (not continuous).

The number of components and the number of intervals should be such that a few thousand different associations are created in mountainous country, or a few hundred in non-mountainous country. These associations occur as intermixed polygons throughout a biogeographic region. Polygons should be from 1–100 ha in size, occasionally larger. If many polygons are larger than 100 ha, then the factor intervals were not small enough and good discrimination cannot be expected. Each polygon should be labeled in a way that indicates the factor levels that determined the polygon. These associations are the precursors required before vegetation classification can be conducted, and in the aggregate create a permanent primary layer.

The second step in determining valid associations is to: (1) determine the existing overall gross vegetation structure (i.e., formation class e.g., forest or scrub) and overlay on the layer of precursor association polygons. Overlaying these 2 layers creates a third layer of ecological associations. Because this third layer was formed from somewhat arbitrary intervals, the lines between the polygons are not optimal, but the fine division of factors and resulting closely related polygons allows for any polygon to be designated as an ecotone polygon if useful. This third overlay is an ecological association map.

The third step in determining valid associations is to obtain the generally agreed upon best vegetation classification map that was determined strictly on the basis of vegetation, and overlay it on the ecological association map. Although the polygons of the strictly vegetation map will generally be larger, the maps should overlay perfectly with groups of the smaller ecological associations fitting precisely within the vegetation map polygons, or matching polygon for polygon. Initial agreement is unlikely. Substantial differences (e.g., the same ecological association pervasive for long distances on both sides of a boundary between 2 classes on the vegetation classification map) should be investigated and adjusted. The final product is a vegetation classification map including ecological associations. Now the stage is set for investigating and mapping animals.

The next step in an investigation (applies to both plants and animals) is to determine the location (i.e., the subregion [nominative]) because that may make a difference in any findings and subsequent applications. The last step, usually only for animals, is to determine the surroundings (e.g., rough terrain, forested [categorical]). At this point investigation of animals by species becomes the focus because each species responds to the surroundings in a different way locally and over large areas. Possibly groups could be characterized as wide-ranging, moderate-ranging, close-ranging, and not ranging.

Investigations to compare the similarity of the relatively small ecological associations (to determine grouping or splitting) can be carried out using small mammals, herptiles, or forbs in grassland and scrub. But if the ecological association consists of taller vegetation with vertical stratification then canopy invertebrates will have to be used to reflect and compare the vertical stratification because birds are too wide ranging and insensitive to compare ecological associations. Note this is a much different goal than comparing large-area units as discussed in the introduction to this study.

If investigations are to compare larger vegetation classifications containing several kinds of ecological associations, then birds are an excellent choice provided other vertebrate species are included to reflect and compare soil and other near-ground factors. For each species investigated the expectation is that either a specific ecological association is critical or definitive (despite the fact that the species uses many associations) or some particular arrangement of ecological associations is needed.

This approach is much different than the coarse top-down approach. The coarse approach does not emphasize the arrangement of small ecological associations. Consequently in the coarse approach it is difficult to determine precisely where species of animals (and plants) occur and why they occur there, and consequently why they occur in the overall gross vegetation class.

Vegetation as a component--Vegetation should be considered just 1 of several components in mapping ecological associations for the conservation of biodiversity. A common belief, repeated in the documentation for a national vegetation classification system (The Nature Conservancy 1998), is that vegetation integrates the ecological processes operating on a site more measurably than any other set of factors, and patterns of vegetation and co-occurring plant species are easily measured. The latter is not true based on the current study.

The difference in the composition of species was not greatly different between a pine forest and a post oak forest. Furthermore, I observed post oak as a dominant on the low clay terraces of the Navasota River and on the tops of sand hills elsewhere. Mapping with dominant plants is somewhat analogous to mapping with cervids (*Cervidae*), they are both too ubiquitous and either not sufficiently or not correctly discriminating. Based on Whittaker (1962) there is no reason to believe the discrimination would improve with any set of species in the absence of some abrupt change in an important environmental factor. An apparent abrupt change in vegetation does not indicate necessarily an abrupt change in any environmental factor or in the composition of species (plant or animal) because the tendency of observers is to evaluate change based on a few obvious species or on appearance (this tendency includes the examination of satellite imagery).

One solution is to inventory every ha but this has no large-area application. Another solution is to inventory a few of each potential vegetation association, find a spectral response pattern that will identify each association, and map from a satellite (or conversely do the reverse). Either way this approach is not very satisfying for the same reason as before (the tendency of observers to evaluate change based on appearance or on a few obvious species when doing ground-truthing, especially over a large area). The approach of mapping by the general appearance of vegetation was essentially the only approach for large areas prior to the 1970s, but the improving ability to measure the important environmental factors by remote sensing creates a strong argument for including environmental factors in defining and mapping associations.

The suggestion to use environmental factors is not made primarily in order to map sites or potential vegetation, but rather to improve vegetation classification and mapping. In so doing mapping of all species will improve. An added benefit is that the site also will be characterized and mapped, and the potential vegetation known with a high degree of certainty.

Within the framework of vegetation as 1 component of an ecological association, vegetation is usually the most important component. Vegetation makes up many of the species, and provides structure for many more. The overall gross vegetation structure is the most important measurement of the vegetation and should always be included in defining a vegetation association or an ecological association. The plant species (floristics) making up the association are less reliable but should be used if either ecological associations or vegetation associations are to be defined and mapped.

In using floristics, every effort should be made not to map the vegetation solely by dominants (except as pertains to overall gross vegetation structure) or allow the dominants to corrupt or interfere with the classification. During ground truthing if quantitative measurements of species are made, other than overall gross vegetation structure, it can be useful to ignore the 5–10 most dominant species because they may be ubiquitous and interfere with discrimination. If presence or absence data are used, as they were in my study, then all species are given the same weight and dominant species can be used without corrupting the classifications.

Vegetation classification--A representative vegetation classification system (The Nature Conservancy 1998) commonly used in the United States is ordered as follows, from highest to lowest level: formation class, formation subclass, formation group, formation subgroup, formation, alliance, association. The difference between the pine forest (mainly evergreen forest) and post oak forest (mainly deciduous forest) is supposed to indicate the second highest level (formation subclass). But the difference between these 2 forest types in the present study was not enough to qualify as an association (Table 6). Analogously, Whittaker (1952) found a natural grouping of foliage insects occurred in both coniferous and deciduous forests.

There are 3 reasons for this contradiction: (1) The classification system does not recognize the individuality of species. Although there are differences between evergreen and deciduous trees this difference does not supersede the potential for a given species within a major structural type (e.g., formation subclass) to be the dominant species in any situation where that formation subclass occurs. (2) The classification system does not recognize the impact of biogeographic factors, particularly barriers and corridors. Vegetation groups within a formation subclass, but with different dominants, may have many species in common over long distances if there are no biogeographic barriers. Conversely, vegetation groups with the same dominant may have few species in common over a short distance if the groups are separated by a barrier breached only by the dominant and few other species. (3) The vegetation classification hierarchy and nomenclature does not have the flexibility needed to adequately define species groups for the purpose of determining complementarity and conserving biodiversity.

Nomenclature--The reasons for naming vegetation associations or species associations (up to and including formation class), and the methods of naming associations, are central to the goal and application of the present study. The current method of naming associations (e.g., The Nature Conservancy [1998] or UNESCO [1973]), although useful for some purposes, is poorly suited for furthering the conservation of biodiversity. A simple and unobtrusive remedy is needed. I suggest adding a suffix to existing names and to de-emphasize upper-level classifications.

For the conservation of biodiversity the utility of names is to state clearly how associations or alliances differ from others in species composition (i.e., the degree of complementarity). If a researcher or manager knows the names of 2 associations, the researcher should know whether the 2 associations likely have few species in common or many species in common. To make this possible requires: (1) the continent or subcontinent or island group, (2) the biogeographic regions of the continent, subcontinent, or island group, and (3) the vegetation formation class (e.g., forest or scrub).

The suffix then would consist of useful abbreviations for these 3 identifiers. An example might be North America; west of the Rocky Mountains; forest. If these were abbreviated respectively, *na*., *wrm*., and *forest*., then the suffix would be: na.wrm.forest.

If biogeographic regions are bounded properly, then within this hypothetical biogeographic region (wrm) any association ending with na.wrm.forest is a forest and is likely to have species in common with other associations ending in na.wrm.forest (low complementarity) and few species in common with associations ending with na.wrm.scrub (moderate complementarity).

Assume the abbreviation for a biogeographic region is *eam* for east of the Appalachian Mountains, and the abbreviation for another continent is *af* for Africa and *wkm* for another biogeographic region. Some suffixes might be: (1) na.wrm.forest, (2) na.eam.forest, and (3) af.wkm.forest. From the suffixes all associations are forest. One of the associations (af.wkm.forest) likely has no species in common with the other 2 associations (high complementarity), although all are forest. The 2 North American associations have few species in common (high complementarity), although both are forest (a few species would be in common [e.g., pileated woodpecker]). It would be immediately obvious that among the forest all had high complementarity, but between the scrub and one of the forest the complementarity was moderate. These comparisons are immediately obvious from the suffix, regardless of the name of the association.

Example

To relate the present study to the background and context given above, the general ecological concepts were applied to the study area. The vegetation formation class was given (forest). The biogeographic region containing the study area was investigated and defined using large-area topographic maps, a world climate map, a world vegetation map, and large-area geology and physiographic maps. Major barriers were concluded to be: (1) the Mississippi River to the east, (2) the northern boundary of the Ozark Plateau (the Missouri River) to the north, (3) the gulf coastal prairie (a formation class) to the south, and (4) the Great Plains (a formation class) to the west. Thus these were the boundaries of the biogeographic region and the region can clearly be seen on the Global 2000 Landcover map (Joint Research Centre 2000).

Two biogeographic subregions were delimited by separating the higher elevations in the north (Ouachita Mountains and Ozark Plateau) from the lower elevations in the south and east (forested Gulf Coastal Plain). But because these are low mountains with no major north-south barrier and with a corridor of lowlands along the eastern edge, like sites in the 2 areas should contain like species. The 2 areas do not appear to warrant biogeographic region status. In the United States this conclusion can be confirmed by vertebrate field guides, and the field guides did confirm the conclusion.

A comprehensive set of species groups was needed for the biogeographic region that would adequately assess the natural structural diversity. Forests often have complex canopies. A group of species was needed for that factor. Birds (using all species) are an excellent choice. Birds are easily surveyed and identified, and bird species occupy different types and levels of canopy. A group of species was needed for soils. Woody plant species are a reasonable choice. Woody plant species are rooted in the soil and are easily surveyed and identified. These 2 groups of species taken together (birds and woody plant species) may be the most parsimonious set of species to adequately extrapolate for comparisons of biodiversity and complementarity. But there may remain some natural structural diversity for which the influence on the distribution of species has not been evaluated.

This lack would include significant features not substantially influential on the distribution of birds and trees. Some examples might include general topographic relief, topographic position (includes wetlands), rocks, ledges, and logs. There are no rocks or ledges or substantial topographic relief in the study area. The objective though is to evaluate candidate large-area units to determine the large-area units with highest biodiversity and complementarity (with the constraints that the units have long-term security and high complementarity with other biogeographic regions). Within the biogeographic region there are rocks and ledges and high topographic relief in the low mountains. A group of species is needed to evaluate and reflect these additional potential factors. A good choice might be all small mammals and herptiles, but these are difficult and costly to survey (possibly 5–10 times the cost of surveying both birds and woody plants and with a lower level of confidence).

In some cases soil differences may not be adequately accounted for by woody plants. Forbs might be a better alternative, but not all forbs, that would be too many and too costly. A selection of a few ecologically diverse families of tall forbs with showy flowers and long blooming periods, not generally invaders or associated with unnatural disturbance, might be a good choice.

All of these groups are meant to contain species throughout the biogeographic region (not the same species throughout except as may commonly be the case for some species in a representative selection of species). Invertebrates were not included in the above scenario or suggestions because the general characteristics of invertebrates do not seem to make them most suitable. It is possible that a group of invertebrates could be found that would better reflect the changes in the structural components logs and snags. But this level of detail might be beyond that needed or desirable for a parsimonious approach to determining the complementarity of large-area units for this biogeographic region. Invertebrates might be needed for the same purpose if the biogeographic region was dominated by tallgrass prairie, although forbs might provide the same information more parsimoniously. Obviously sets of species are also needed to evaluate the aquatic environments, but these are beyond the scope of the present study.

In the present study there was no barrier (except the relatively small Trinity River) between the western portion (post oak forest) and the eastern portion (pine forest), therefore it should have been recognized a priori that these 2 areas would not be separate biogeographic regions. The western post oak dominated area perhaps would be better described as an ecotone boundary. It is linear and generally 50–100 km in width. It is between a forested biogeographic region and a herbaceous biogeographic region, and it is the result of a smooth environmental gradient of increasing aridity from east to west.

The boundaries that impede the exchange of species and delimit the biogeographic region were given above. If this biogeographic region was assigned the name *opetmr* (for Ozark Plateau to east Texas and to the Mississippi River), and na means North America, then any forest association in this biogeographic region would be given the a priori suffix na.opetmr.forest and it would be known a priori that these forest associations likely have many species in common. It would also be immediately clear that an oak-hickory association in this biogeographic region likely will have few species in common with an oak-hickory association in Georgia, USA, and likely none with an oak-hickory association in China.

With care and effort a better choice of abbreviations for suffixes could be attained than I have presented here. For utility and acceptance, the meaning of the abbreviations for each of the 3 parts (continent, biogeographic region, and vegetation formation) should be obvious and easy to remember. If the improvement in nomenclature were adopted in any area, the potential for wider use would be enhanced.

SUMMARY AND MANAGEMENT IMPLICATIONS

Holdridge (1967:11) notes that in 1823 J. F. Schouw published information on the effects of light, temperature, and humidity on the distribution of vegetation. Chapman (1926) found that light, temperature, and moisture are important in ecology. Regarding the classification of plant communities, Nichols (1923:11) stated "So much has been written, indeed, that one feels somewhat hesitant about adding anything further to the already voluminous literature on the subject." Similarly, in this study nothing new is added except some details that could have been deduced from much earlier information. One problem is that too often investigators do not place their findings within a logical framework in the overall scheme of efforts in ecology and conservation (probably because editors will not let them do it). I attempted to place the research and the findings in context.

Findings

(1) In this study dominant tree was more strongly associated with the distribution of species overall in the 6 groups analyzed than subsoil texture.

(2) The factors dominant tree and subsoil texture were weakly correlated, and when used together substantially improved the cumulative variance explained for the distribution of species within the 6 groups analyzed.

(3) Within the study area, and based on the 6 groups analyzed, the

deciduous post oak forest and the evergreen pine forest belong to the same association, or possibly to the same subassociation.

(4) For the purpose of predicting the occurrence of species groups and complementarity, the use of the formation subclass dichotomy of evergreen versus deciduous was unwarranted.

(5) The use of the formation class dichotomy of shrubland versus forest was warranted.

(6) Evergreen forests and deciduous forests do not necessarily have high complementarity.

(7) Different dominant plant species do not necessarily define different associations.

(8) Dominant plant species are not necessarily useful in defining associations or higher level classifications.

Plausible Adjuncts

(1) The presence or absence data type may be the most parsimonious and appropriate data for assessing biodiversity.

(2) Whittaker (1962) was correct in asserting species are distributed individualistically. Dominants or any other species do not define an association in the absence of an abrupt environmental discontinuity. Clements (1936) was not necessarily wrong when he said the life-form of the dominant trees stamps its character upon forest and woodland. He did not say the species of the

dominant tree. It is true the overall gross vegetation structure (i.e., vegetation formation class (e.g., forest, scrub, or herbaceous) internally affects the primary factors of temperature, moisture, and insolation (sunlight) and therefore other species. Also some species are simply correlated with the same factors that caused the overall gross vegetation structure.

(3) The general overall gross vegetation structure resulting from dominant plants is important in separating species into well-defined groups of species, but the species of the dominant plants creating the structure are of less importance in defining groups of species and may be almost interchangeable.

(4) Real boundaries between distinct species groups are primarily caused by physical factors. Overall gross vegetation structure is 1 of these physical factors, but usually real boundaries are caused by abrupt changes in geology, soils, or topography. Temporary boundaries (20–50 years) may be caused by man-made or catastrophic events. These events may cause real permanent (centuries) boundaries if the physical factors are changed as by soil erosion, impeded drainage, or the stochastic establishment of a different and persistent overall gross vegetation structure.

(5) There is no good reason to map vegetation without the use of important site variables because such mapping is: (a) less accurate, (b) soon outdated, (c) not optimum for predicting the response to disturbance or management, (d) not a good predictor of the nature of the surrounding area, and (e) an end in itself without application or at least not a parsimonious and

optimized application.

(6) The current nomenclature (The Nature Conservancy 1998) used in vegetation mapping is not useful or at least not optimized to assist in the conservation of biodiversity because the nomenclature does not take into account the higher correlation of species and species composition for all associations within a biogeographic region, or conversely, the lower correlation of species and species composition among biogeographic regions despite some or many of the sites among regions having the same environmental values and the same dominant species.

Nomenclature

Currently the hierarchy of vegetation classification provides little information about the complementarity among vegetation classifications at any level. An oak-hickory association may have no species in common with another oak-hickory association but many species in common with a pine association. For utility and efficiency the names of vegetation alliances and associations should convey information on complementarity. To convey this information the name must include: (1) the continent (or sub continent or major island group), (2) the biogeographic region, and (3) the vegetation formation class. To interfere least with current names I suggest the information be attached as a suffix. An example would be: NorthAmerica.EdwardsPlateau.Scrub. For utility and acceptance the meaning of the abbreviations for each of the 3 parts of the suffix should be obvious and easy to remember. Properly bounded biogeographic regions are critical to the reliability of the suffixes, and to the conservation of biodiversity in general.

Currently only those people familiar with the associations in an area can make intuitive assessments of the complementarity among those associations. These same people generally cannot make intuitive assessments of the complementarity of their biogeographic region with another biogeographic region unfamiliar to them. The suffixes provide a method for all persons to make rapid qualitative assessments of the complementarity within and among biogeographic regions. The widespread use of suffixes should foster a better general understanding and appreciation of associations, biogeographic regions, and the conservation of biodiversity.

Mapping

Vegetation mapping can have several goals, whatever the goal is, it should be explicit and the methods of mapping optimized to meet the goal. One goal of vegetation mapping is the conservation of biodiversity. Vegetation is often said to integrate physical factors, but this is a species concept more than a community concept. For example American beautyberry occurs on acid sandy soils in the woodlands of east Texas and on calcareous alluvial soils in the canyons of the Edwards Plateau in west central Texas. The integration of different factors apparently meets the life requisites of this species, but few other species are found with American beautyberry in both locations. The ability to flourish by responding to the integration of markedly different levels of factors can also be true of dominant species. Whether other species are able to cope with different situations is uncertain and depends on the species. Defining associations by dominants is risky and the results should always be viewed with skepticism although some results are excellent. Different species can dominate the same association (this statement seems an oxymoron only because of preconceived notions).

Nicolson and McIntosh (2002:138) quote Taper (1995) as stating "The fact that species respond individualistically does not imply that species do not respond deterministically to abiotic conditions and to other species." Surely every professional ecologist today knows this statement to be correct in its entirety, but the ramifications do not seem to be appreciated. Each species is responding individualistically to each environmental (abiotic) factor. The same set of species can only be expected to occur where the same set of environmental factors (and their levels) occurs. Vegetation is only 1 component in determining or characterizing the composition of an association, and not necessarily the most important component.

Renkonen (1949:126) stated "In grouping animal populations, it is most reasonable to start from their own structure and only examine corresponding habitats after having done the groupings. In this way the risk of anthropocentric prejudices can be avoided." This statement is conceptually more relevant for plants because from the beginning classifications were identified first and then the constituent species composition described. Anthropocentric prejudices were introduced because of preconceived notions that differences in physical appearances (e.g., color, grain, or aspect dominance) were fundamental to defining different associations.

In earlier times the approach of mapping solely by vegetation was necessary because the environmental factors could not be measured over large areas. Currently, the ability to measure and map basic environmental factors by remote sensing has created new options. Associations should no longer be defined and mapped solely by dominants or plants. Environmental factors from remote sensing should be included, and not just as ancillary data, but as an integral components on which the definition of an association is based. Failure to focus on the environmental factors in the past likely made vegetation seem more stochastic than it is, and likely 1 reason why vegetation classifications do not seem to relate well to animals.

Because existing vegetation remains 1 component in the conceptual scheme of defining associations presented above, the abiotic factors alone cannot define an association. Two or more sites may have the same abiotic factors and levels of those factors, and be different associations. In fact this situation is often the case because of disturbance and succession. For the purpose of conserving biodiversity, the use of environmental factors to define and map associations is to: (1) obtain a more accurate classification of existing vegetation, (2) ensure that a given association is the same everywhere it is mapped, (3) ensure that the ability to predict future associations on the same site is optimized, and (4) ensure that the distribution of animals species is optimally related to the distribution of vegetation species (i.e., a vegetation association is also an ecological association is also an animal association [as noted earlier *ecological association* herein is a general term analogous to vegetation association but includes animals and all abiotic factors]).

The utility of the ecological association in predicting the occurrence of animal species is likely to be less than for plant species, but useful nonetheless. Regardless, the ecological association (and the arrangement of ecological associations) provides the best prediction for animal species because there is nothing else to measure except the animals and it is not feasible to obtain measurements by remote sensing on thousands of animal species that are essentially invisible.

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APPENDIX A

Ant (*Formicidae*) and velvet ant (*Mutillidae*)[a] presence (1) or absence (_) in 60 plots each inventoried by 1 pitfall trap with 3 5-m wings for 10 consecutive days sometime during the period 1 March 1996 to 31 October 2002 on an east Texas upland forest study area[b].

Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Acanthomyops interjectus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Acanthomyops latipes	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Aphaenogastor lamellidens	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	1	_	_	_	_	1	_	_	_	_	_
Aphaenogastor rudis	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Aphaenogastor sp. 1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Aphaenogastor texana	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Atta texana	_	_	_	_	1	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Camponotus castaneus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Camponotus ferrugineus	_	1	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	1	1	_	_	_	_	1	_	1	_	_	1
Camponotus pennsylvanicus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Crematogaster ashmeadi	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_
Crematogaster clara	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Crematogaster lineolata	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dorymyrmex pyramicus	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Forelius pruinosis	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Labidus coecus	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lasius alienus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Leptogenys elongata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Monomorium minimum	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pachycondyla harpax	_	_	_	_	1	1	_	_	1	_	_	1	1	_	_	_	_	_	_	_	1	1	1	_	_	_	1	1	1	_
Pheidole dentate	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Solenopsis invicta	1	1	_	1	_	_	1	_	1	_	1	_	_	_	1	1	1	_	1	1	_	_	_	1	_	1	1	_	_	_

Appendix A (continued). Part 1: plots 1 to 45

Species	Plot																												
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Dasymutilla angulata	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla asopus	1	_	1	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla atrifimbriata	_	_	_	_	_	_	1	1	1	_	1	_	_	1	1	_	1	1	1	1	1	_	_	_	_	_	_	1	1	_
Dasymutilla biguttata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla birkmani	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla bollii	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla corcyra	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla mutata	1	_	1	1	_	_	_	1	_	1	1	1	1	1	_	_	_	_	1	1	_	1	_	1	_	1	_	1	1	_
Dasymutilla nigricauda	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	_
Dasymutilla nigripes	_	1	1	_	_	_	_	1	1	_	_	_	_	1	_	_	_	1	_	_	_	_	_	1	_	1	_	1	1	_
Dasymutilla occidentalis	1	1	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Dasymutilla parksi	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla quadriguttata	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla vesta	_	_	1	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	1	1	1	_	_
Dasymutilla waco	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_
Ephuta sp. 1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ephuta sudatrix	_	_	1	_	_	_	_	_	_	_	1	_	_	1	_	_	1	_	_	_	_	_	_	_	1	_	_	_	1	_
Myrmilloides grandiceps	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	1	1	_	_
Photomorphus sp. 1	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Psuedomethoca frigida	1	1	1	_	_	_	1	_	_	1	1	_	_	_	_	_	1	1	1	1	_	_	_	_	_	1	1	_	_	_
Psuedomethoca ilione	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Psuedomethoca oceola	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Psuedomethoca propinqua	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Psuedomethoca sanbornii	1	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_
Psuedomethoca simillima	1	_	_	_	_	_	1	1	1	_	_	_	_	1	1	1	1	1	1	_	1	_	_	1	1	1	1	_	1	1
Psuedomethoca vanduzei	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Sphaeropthalma auripilis	_	_	_	_	_	_	_	1	_	_	1	_	1	_	_	1	1	_	_	1	_	_	_	_	_	_	_	_	1	_
Timulla euterpe	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_

Appendix A (continued). Part 1: plots 1 to 45

Species	Plot																												
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Timulla floridensis	_	_	_	1	_	_	1	1	_	_	_	_	_	1	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Timulla oajaca	1	_	1	_	_	_	_	1	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Timulla wileyae	1	1	1	1	_	_	1	1	1	1	1	_	_	1	1	1	1	1	1	1	1	_	_	1	_	1	1	_	_	1

Appendix A (continued). Part 2: plots 46 to 91

Species	Plot																												
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Acanthomyops interjectus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Acanthomyops latipes	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Aphaenogastor lamellidens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_
Aphaenogastor rudis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Aphaenogastor sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Aphaenogastor texana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Atta texana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Camponotus castaneus	_	_	_	_	_	_	_	_	1	_	1	_	_	1	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Camponotus ferrugineus	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Camponotus pennsylvanicus	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Crematogaster ashmeadi	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1
Crematogaster clara	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Crematogaster lineolata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dorymyrmex pyramicus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Forelius pruinosis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Labidus coecus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lasius alienus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Leptogenys elongata	_	_	_	1	_	_	1	_	_	_	1	_	_	_	_	_	_	_	1	1	1	1	_	_	1	1	_	_	_	_

Appendix A (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Monomorium minimum	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Pachycondyla harpax	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pheidole dentate	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Solenopsis invicta	_	_	1	_	_	_	1	_	1	_	_	_	1	1	_	_	1	_	_	_	_	_	1	_	_	1	1	1	1	_
Dasymutilla angulata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla asopus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla atrifimbriata	_	1	1	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	1	_	_	1	_	_	1	_	_	_	1	1
Dasymutilla biguttata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla birkmani	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla bollii	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla corcyra	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla mutata	_	1	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	1	_	_	1	_
Dasymutilla nigricauda	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla nigripes	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	1	_
Dasymutilla occidentalis	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla parksi	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla quadriguttata	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_
Dasymutilla vesta	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Dasymutilla waco	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ephuta sp. 1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ephuta sudatrix	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Myrmilloides grandiceps	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Photomorphus sp. 1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Psuedomethoca frigida	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	1	_	_	1	_
Psuedomethoca ilione	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Psuedomethoca oceola	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Psuedomethoca propinqua	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Psuedomethoca sanbornii	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_

Appendix A (continued). Part 2: plots 46 to 91

	Plot																													
Species	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Psuedomethoca simillima	_	_	_	_	_	1	1	1	1	_	1	1	_	_	_	1	1	_	1	1	_	_	_	_	_	1	_	_	1	1
Psuedomethoca vanduzei	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sphaeropthalma auripilis	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Timulla euterpe	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Timulla floridensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Timulla oajaca	_	_	_	_	_	1	1	1	_	_	_	1	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	1	1	_
Timulla wileyae	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	1	_	1	_

[a] Ants were identified to species by Bill Summerlin, Entomology Department, Texas A&M University. Velvet ants were identified to species by Donald G. Manley, Pee Dee Research and Education Center, Clemson University.

[b] Plots are not numbered consecutively, but rather are named by number. Approximate plot locations and dates of collections (i.e. herp array dates) are in Table 1.

APPENDIX B

Beetle (Coleoptera)[a] species presence (1) or absence (_) in 60 plots each inventoried by 1 pitfall trap with 3 5-m wings for 10 consecutive days sometime during the period 1 March 1996 to 31 October 2002 on an east Texas upland forest study area[b].

Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Aegomorphus quadrigibbus	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Agonum striatopunctatum	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Agonum pallipes	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Agonum punctiforme	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	1	_	1
Alaus myops	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Alobates morio	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	1	_	_	_	1	_	_	1	_	_	_	_	1	_
Alobates pensylvanica	_	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	1	1	1	_	_	_	_	1	_
Amara obesa	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Amara sp. 1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_
Ampedus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_
Amphasia interstitialis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Anisodactylus dulcicollis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	1	_	_	_	_	_	_
Anisodactylus furvus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Anisodactylus sp. 1	_	_	_	1	_	1	1	1	_	_	_	_	_	1	1	1	_	_	1	1	1	1	_	_	_	1	1	_	_	1
Anomala marginata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Apenes sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Aphorista vittata	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Aspidoglossa subangulata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Ataenius sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Badister notatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Blapstinus fortis	1	_	1	1	_	1	_	_	_	1	_	_	_	1	1	1	_	_	_	_	1	_	_	1	_	_	_	1	_	1
Brachinus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Brachinus sp. 2	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	1	_	_	_	_	_
Brachinus sp. 3	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Calathus opaculus	_	_	1	_	_	1	_	1	1	_	_	_	1	_	1	1	1	_	_	_	1	_	_	_	_	_	1	_	1	_

Appendix B (continued). Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Calosoma scrutator	_	_	_	_	_	_	_	_	1	_	_	1	1	_	_	_	_	_	_	_	1	1	1	1	1	_	_	_	_	1
Calosoma wilcoxi	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Calosoma sayi	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Canthon vigilans	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Canthon viridis	_	_	_	_	_	1	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	_
Capraita thyamoides	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Centronopus opacus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_
Chalcodermus sp. 1	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Chlaenius impunctifrons	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Chlaenius erythropus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Chlaenius sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Chrysobothis sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Chrysolina auripennis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_
Cicindela sexguttata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Clivina bipustulata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Clivina postica	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Conotrachelus posticatus	_	_	_	_	1	1	_	_	1	_	_	1	_	_	_	_	1	_	_	1	_	1	_	1	_	_	_	1	1	_
Conotrachelus sp. 1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Conotrachelus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Cophes fallax	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Copris minutus	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Cossonus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cryptorhynchus fuscatus	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cryptorhynchus tristis	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Ctenicera inflata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cymatodera sp. 1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cymatodera sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cymindis limbatus	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	1
Danae testacea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 1: plots 1 to 45

Species	Plot																													
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Deltochilum gibbosum	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dicaelus crenatus	_	_	1	_	1	1	1	_	_	1	1	_	_	_	_	_	1	1	_	_	_	_	_	_	1	1	1	1	_	1
Dicaelus elongatus	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Dicaelus furvus	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	1	_	_	_	_
Diplotaxis sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Disonycha discoidea	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Distenia undata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Eleodes tricostatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Eudiagogus rosenschoeldi	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Euetheola humilis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Fidia sp. 1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Galerita bicolor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_
Geotrupes blackburnii	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Geotrupes opacus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Glyptotus cribratus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gonwanocrypticus obsoletus	1	_	1	1	_	_	_	1	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_
Haplandrus ater	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Harpalus sp. 1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Harpalus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Helluomorphoides nigripennis	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	1
Helluomorphoides praeustus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Helops cisteloides	_	_	_	_	_	_	_	1	1	_	_	_	_	1	_	_	_	1	_	_	1	_	_	1	_	1	_	_	_	_
Hemicrepidius sp. 1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Hipcodamia convergens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Homeolabus analis	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hylobius pales	1	_	_	1	_	_	_	_	_	1	1	_	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_	_	_	_
Hymenorus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Isomira sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Isomira sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Kuschelina petaurista	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 1: plots 1 to 45

Species	Plot																													
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Leptinotarsa haldemani	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Leptostylus transversus	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Limonius sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Listroderes costirostris	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Listronotus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Listronotus sp. 2	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lixus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lixus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lobopoda sp. 1	_	1	1	_	_	1	_	_	_	1	_	_	_	_	1	1	_	1	_	_	1	_	_	_	_	_	_	_	_	_
Lophoglossus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Loxandrus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Loxandrus sp. 2	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lucanus placidus	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lycoperdina ferruginea	1	_	_	1	_	1	_	1	_	_	_	_	_	_	_	1	_	_	_	_	1	_	1	_	1	_	_	_	_	1
Maemactes cribratus	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Melanactes sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Melanocanthon nigricornis	1	_	1	1	_	_	_	1	1	1	1	1	1	1	_	1	_	_	_	1	1	1	1	1	_	1	1	1	1	_
Melanotus insipiens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Melanotus morosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Melanotus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Melanotus sp. 2	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Meloe sp. 1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Merinus laevis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1	_	_
Metachroma longicolle	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Monochamus sp. 1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Naupactus peregrinus	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Necrodes surinamensis	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Necrophila americana	1	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Nicrophorus orbicollis	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_	_	_	_
Nicrophorus pustulatus	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Nicrophorus tomentosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Notiobia sayi	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Notiobia terminata	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Notiophilus novemstriatus	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Odontotaenius disjunctus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_
Oiceoptoma inaequale	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Oiceoptoma rugulosum	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Omileus epicaeroides	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Omorgus monachus	_	_	_	1	_	_	1	_	_	_	1	_	_	_	1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Onthophagus medorensis	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Onthophagus striatulus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Onthophagus tuberculifrons	_	_	_	_	_	1	_	_	1	_	_	_	_	1	_	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_
Onthophagus hecate	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Onthophagus pennsylvanicus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Onthophagus subaeneus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Opatrinus minimus	_	1	_	1	_	_	1	_	_	1	1	_	_	1	1	_	1	1	_	1	_	_	_	_	_	1	_	_	_	_
Pachylobius picivorus	_	_	1	_	1	_	_	_	_	1	1	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	1
Panagaeus fasciatus	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Pentagonica sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Penthe pimelia	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phaedon viridis	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Photinus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phyllophaga calceata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phyllophaga crenulata	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phyllophaga micans	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Phyllophaga profunda	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Phyllophaga prunina	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phyllophaga sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Platydema micans	_	_	_	_	_	_	_	_	1	_	_	_	1	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Platydema ruficolle	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_

Appendix B (continued). Part 1: plots 1 to 45

Species	Plot																												
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Platydracus fossator	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Platydracus maculosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Platydracus sp. 1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	1	_	_	_	1
Platydracus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Platynus sp. 1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Poecilocrypticus formicophilus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Polypleurus geminatus	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Prionus pocularis	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pterostichus premundus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_
Pterostichus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pyractomena sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rhadine sp. 1	_	_	1	1	1	1	_	_	_	1	_	1	_	1	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	_
Scaphinotus elevatus	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1
Scaphinotus liebecki	_	_	_	_	1	1	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	1
Selenophorus sp. 1	_	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	1	_	_	_
Selenophorus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Selenophorus sp. 3	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Semiardistomis puncticollis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_
Serica parallela	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Serica sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Serica sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Sericus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Sphenophorus bartramiae	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_	_	_	1	_
Sphenophorus coesifrons	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	1
Sphenophorus destructor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Sphenophorus germari	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sphenophorus holosericus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Sphenophorus parvulus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sphenophorus venatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Statira sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 1: plots 1 to 45

Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Stenocrepis sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Stenomorphus californicus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_
Temnochila sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Tenebroides corticalis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Tetragonoderus intersectus	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Thesesternus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Trichotichnus dichrous	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_
Tritoma sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1
Trox spinulosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Trox variolatus	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Tyloderma baridium	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Tymnes tricolor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Typocerus lunulatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Typocerus zebra	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Uloma imberbis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ulus elongatulus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Xanthonia sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Xylobiops basilaris	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 2: plots 46 to 91

Species	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Aegomorphus quadrigibbus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Agonum striatopunctatum	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Agonum pallipes	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Agonum punctiforme	_	1	1	1	1	_	1	_	_	1	1	1	1	_	_	1	_	1	1	_	_	_	1	1	1	_	_	_	_	_
Alaus myops	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Alobates morio	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1	_	1	_	_	1	_	_	_	_
Alobates pensylvanica	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	1	_	_	1	_	_	_	1	_
Amara obesa	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Amara sp. 1	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	1	1	_	_	_	_	1	1	_	_	_	_	_	_
Ampedus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Amphasia interstitialis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Anisodactylus dulcicollis	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_
Anisodactylus furvus	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Anisodactylus sp. 1	1	_	1	_	_	1	_	_	_	1	_	1	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Anomala marginata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Apenes sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Aphorista vittata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Aspidoglossa subangulata	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ataenius sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Badister notatus	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Blapstinus fortis	_	_	1	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_
Brachinus sp. 1	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Brachinus sp. 2	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Brachinus sp. 3	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Calathus opaculus	_	_	_	1	1	_	_	_	_	1	1	_	_	_	_	_	_	_	1	1	_	1	_	_	_	_	_	_	_	_
Calosoma scrutator	1	1	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_	1	1	_	1	_	_	_	_	_	_	_
Calosoma wilcoxi	_	_	_	_	_	1	1	_	_	_	_	1	_	_	_	1	1	_	_	_	1	_	1	1	_	1	_	_	_	_
Calosoma sayi	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Canthon vigilans	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Canthon viridis	_	1	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1
Capraita thyamoides	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Centronopus opacus	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Chalcodermus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Chlaenius impunctifrons	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Chlaenius erythropus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 2: plots 46 to 91

	Plot																													
Species	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Chlaenius sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Chrysobothis sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Chrysolina auripennis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cicindela sexguttata	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Clivina bipustulata	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Clivina postica	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Conotrachelus posticatus	_	_	_	_	1	1	_	_	_	1	_	1	_	_	_	_	_	_	1	1	_	1	_	_	_	_	_	_	_	_
Conotrachelus sp. 1	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Conotrachelus sp. 2	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cophes fallax	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Copris minutus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cossonus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Cryptorhynchus fuscatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cryptorhynchus tristis	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ctenicera inflata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_
Cymatodera sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_
Cymatodera sp. 2	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cymindis limbatus	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_
Danae testacea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Deltochilum gibbosum	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Dicaelus crenatus	1	_	1	1	_	1	1	1	_	1	_	_	_	1	1	_	1	_	1	_	_	_	_	_	_	_	_	1	1	_
Dicaelus elongatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_
Dicaelus furvus	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Diplotaxis sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Disonycha discoidea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Distenia undata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Eleodes tricostatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Eudiagogus rosenschoeldi	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Euetheola humilis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Fidia sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Galerita bicolor	_	_	1	1	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Geotrupes blackburnii	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Geotrupes opacus	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Glyptotus cribratus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gonwanocrypticus obsoletus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Haplandrus ater	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Harpalus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Harpalus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Helluomorphoides nigripennis	1	_	_	_	_	_	_	_	1	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_
Helluomorphoides praeustus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Helops cisteloides	1	1	1	_	_	1	_	_	1	_	_	1	_	1	1	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_
Hemicrepidius sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hipcodamia convergens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Homeolabus analis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Hylobius pales	1	1	1	_	_	_	_	1	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	1	1	_	_
Hymenorus sp. 1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Isomira sp. 1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Isomira sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Kuschelina petaurista	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Leptinotarsa haldemani	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Leptostylus transversus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Limonius sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Listroderes costirostris	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Listronotus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Listronotus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lixus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lixus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lobopoda sp. 1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lophoglossus sp. 1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Loxandrus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 2: plots 46 to 91

	Plot																													
Species	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Loxandrus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lucanus placidus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lycoperdina ferruginea	_	_	_	_	_	1	1	_	_	1	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_
Maemactes cribratus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Melanactes sp. 1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Melanocanthon nigricornis	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	1	_
Melanotus insipiens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Melanotus morosus	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Melanotus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Melanotus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Meloe sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Merinus laevis	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Metachroma longicolle	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Monochamus sp. 1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Naupactus peregrinus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Necrodes surinamensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Necrophila americana	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	1
Nicrophorus orbicollis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1
Nicrophorus pustulatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Nicrophorus tomentosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Notiobia sayi	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Notiobia terminata	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Notiophilus novemstriatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Odontotaenius disjunctus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1
Oiceoptoma inaequale	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_
Oiceoptoma rugulosum	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Omileus epicaeroides	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Omorgus monachus	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	1	1
Onthophagus medorensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Onthophagus striatulus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Onthophagus tuberculifrons	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Onthophagus hecate	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Onthophagus pennsylvanicus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Onthophagus subaeneus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Opatrinus minimus	_	_	1	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	1
Pachylobius picivorus	1	_	_	_	_	_	_	1	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	1	1	_	1
Panagaeus fasciatus	_	_	_	1	_	_	1	_	_	_	_	1	_	_	_	_	1	_	_	_	1	_	_	_	_	1	_	1	_	_
Pentagonica sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Penthe pimelia	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phaedon viridis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Photinus sp. 1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phyllophaga calceata	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phyllophaga crenulata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Phyllophaga micans	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phyllophaga profunda	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Phyllophaga prunina	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phyllophaga sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Platydema micans	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Platydema ruficolle	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Platydracus fossator	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Platydracus maculosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Platydracus sp. 1	1	1	_	1	_	1	_	1	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Platydracus sp. 2	_	_	_	1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Platynus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Poecilocrypticus formicophilus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Polypleurus geminatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Prionus pocularis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pterostichus premundus	1	_	_	_	_	1	1	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pterostichus sp. 1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pyractomena sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_

Appendix B (continued). Part 2: plots 46 to 91

Species	Plot																												
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Rhadine sp. 1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Scaphinotus elevatus	1	1	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Scaphinotus liebecki	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Selenophorus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Selenophorus sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_
Selenophorus sp. 3	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Semiardistomis puncticollis	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Serica parallela	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Serica sp. 1	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Serica sp. 2	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sericus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sphenophorus bartramiae	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_
Sphenophorus coesifrons	1	_	1	1	1	_	1	_	1	_	_	_	_	_	_	_	_	1	1	_	_	_	_	1	_	_	_	1	1	_
Sphenophorus destructor	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Sphenophorus germari	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sphenophorus holosericus	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sphenophorus parvulus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Sphenophorus venatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Statira sp. 1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Stenocrepis sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Stenomorphus californicus	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Temnochila sp. 1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Tenebroides corticalis	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Tetragonoderus intersectus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Thesesternus sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Trichotichnus dichrous	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Tritoma sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_
Trox spinulosus	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Trox variolatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Tyloderma baridium	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix B (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Tymnes tricolor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Typocerus lunulatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Typocerus zebra	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Uloma imberbis	_	_	1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ulus elongatulus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Xanthonia sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Xylobiops basilaris	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_

[a] Beetles were identified to species by Edward G. Riley, Entomology Department, Texas A&M University.

[b] Plots are not numbered consecutively, but rather are named by number. Approximate plot locations and dates of beetle collections (i.e. herp array dates) are in Table 1.

APPENDIX C

Bird species (Aves)[a] presence (1) or absence (_) in 60 1-ha plots each inventoried by 2 4-hour point count periods (beginning 1.5 hrs before sundown and 1.5 hrs before sunrise) in the spring sometime during the period 1 March 1996 to 31 October 2002 on an east Texas upland forest study area[b].

Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Archilochus colubris	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Baeolophus bicolor	1	1	_	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1
Bubo virginianus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Buteo lineatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Caprimulgus carolinensis	1	_	1	1	1	1	1	1	_	1	_	1	1	1	_	1	1	1	1	_	_	_	1	1	_	1	1	1	1	1
Cardinalis cardinalis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1
Chordeiles minor	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Coccyzus americanus	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1
Contopus virens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	1	_	_	_	_	_	_	_	_
Corvus brachyrhynchos	1	1	1	1	1	1	_	1	1	_	_	1	1	1	_	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1
Cyanocitta cristata	1	_	1	_	_	1	1	1	1	1	1	1	1	_	1	1	1	1	_	_	_	_	1	_	_	1	1	1	1	1
Dendroica dominica	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dendroica pinus	1	1	_	1	_	1	_	_	_	_	1	_	_	_	_	1	1	1	1	1	_	_	_	_	1	1	_	_	_	1
Dryocopus pileatus	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	1	_	_	_	_	1	_	1
Dumetella carolinensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Empidonax virescens	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Geococcyx californianus	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hylocichla mustelina	_	_	1	_	1	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_
Icteria virens	_	_	_	1	_	_	1	_	_	1	_	_	_	_	_	1	_	1	1	1	_	_	_	_	_	1	_	_	_	1
Limnothlypis swainsonii	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Megascops asio	_	_	1	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1

Appendix C (continued). Part 1: plots 1 to 45

Species	Plot																													
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Melanerpes carolinus	1	_	1	1	_	_	1	1	1	1	1	_	_	1	_	1	1	1	_	1	_	1	1	1	_	1	_	1	_	1
Melanerpes erythrocephalus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Mniotilta varia	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_
Molothrus aeneus	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Molothrus ater	_	_	_	_	_	1	1	1	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_
Myiarchus crinitus	_	_	_	_	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	_	1	_	1
Oporornis formosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	_	_	1	_	1	_	_	_	_
Passerina caerulea	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Passerina ciris	_	_	_	_	_	1	_	_	1	_	_	_	1	1	_	_	_	_	_	_	1	1	_	1	_	_	1	1	1	_
Passerina cyanea	1	_	1	1	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_
Picoides pubescens	_	_	_	_	_	_	_	1	1	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_
Picoides villosus	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Piranga rubra	1	1	_	1	1	1	_	1	1	_	1	1	1	_	1	1	1	1	1	1	_	_	1	_	_	_	_	1	1	_
Poecile carolinensis	1	_	_	1	_	1	_	1	1	_	_	1	_	1	1	_	1	1	_	_	1	1	1	1	_	_	_	1	_	1
Polioptila caerulea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Progne subis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Scolopax minor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Sitta carolinensis	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_
Strix varia	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_
Thryothorus ludovicianus	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tyto alba	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Vireo flavifrons	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	1	_	_	_	_	_	1	_	_	_	_	1	_	_
Vireo gilvus	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Vireo griseus	_	1	_	_	_	_	1	1	1	_	_	1	1	1	1	1	_	1	_	_	1	1	1	1	_	1	1	1	1	_
Vireo olivaceus	1	1	1	1	_	1	1	_	_	1	1	1	_	1	1	1	1	1	_	1	_	1	1	_	_	1	_	1	1	1
Wilsonia citrina	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_
Zenaida macroura	1	1	1	1	_	_	1	1	_	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1

Appendix C (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Archilochus colubris	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Baeolophus bicolor	1	1	1	1	1	1	1	_	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bubo virginianus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Buteo lineatus	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Caprimulgus carolinensis	1	1	1	_	_	_	_	1	1	_	_	_	1	1	_	1	1	_	1	1	1	_	_	_	_	1	_	_	1	_
Cardinalis cardinalis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chordeiles minor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Coccyzus americanus	_	_	1	1	1	1	1	_	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Contopus virens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Corvus brachyrhynchos	_	1	1	_	1	1	1	1	1	1	1	1	1	1	_	_	1	1	1	1	1	1	1	1	1	1	1	_	1	1
Cyanocitta cristata	1	1	1	_	1	_	_	1	_	_	1	_	1	_	_	1	1	1	1	1	1	1	_	1	_	1	1	1	1	1
Dendroica dominica	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dendroica pinus	1	1	1	_	_	_	_	1	1	_	_	_	_	1	1	_	_	_	_	1	_	_	_	_	_	1	1	1	1	1
Dryocopus pileatus	1	_	1	_	1	1	_	_	_	_	_	_	1	_	1	_	_	1	1	1	_	_	_	1	1	_	1	1	1	1
Dumetella carolinensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Empidonax virescens	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Geococcyx californianus	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hylocichla mustelina	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Icteria virens	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Limnothlypis swainsonii	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Megascops asio	1	_	_	_	_	_	_	1	1	1	_	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_	_	_	_	_
Melanerpes carolinus	1	1	1	_	_	1	1	_	_	_	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	_	1	_	1	1
Melanerpes erythrocephalus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Mniotilta varia	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Molothrus aeneus	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Molothrus ater	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	1

Appendix C (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Myiarchus crinitus	_	1	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Oporornis formosus	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Passerina caerulea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Passerina ciris	_	_	_	_	_	1	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	1	1	1	_	_	_	_	_
Passerina cyanea	_	_	1	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Picoides pubescens	_	_	1	1	1	1	1	_	_	_	_	1	1	_	_	_	1	_	_	1	_	1	1	_	_	_	_	_	_	_
Picoides villosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Piranga rubra	1	1	1	_	1	_	1	1	_	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	1	1	1
Poecile carolinensis	1	1	_	1	_	1	1	_	_	1	1	1	1	_	_	_	1	1	1	1	1	1	1	1	1	1	_	1	_	1
Polioptila caerulea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Progne subis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Scolopax minor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sitta carolinensis	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Strix varia	_	_	1	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	1	1	_	_	_	_	_
Thryothorus ludovicianus	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tyto alba	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Vireo flavifrons	_	_	_	_	_	1	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1
Vireo gilvus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Vireo griseus	_	1	1	1	1	1	1	1	1	1	_	_	1	1	1	1	1	1	1	_	1	1	1	1	1	1	_	1	1	_
Vireo olivaceus	1	1	1	_	1	_	_	_	_	1	_	_	_	1	1	_	_	_	_	1	_	_	_	_	_	_	_	1	1	1
Wilsonia citrina	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	1	1	1	1
Zenaida macroura	1	_	1	1	1	1	1	1	_	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	_	1	_	1	1	1

[a] Bird names follow the American Ornothologists' Union Check-list of North American Birds; (2004 electronic).

[b] Plots are not numbered consecutively, but rather are named by number. Appproximate plot locations and bird survey dates are in Table 1.

APPENDIX D

Herptile (*Amphibia, Reptilia*) and small mammal (*Mammalia*)[a] species presence (1) or absence (_) in 60 plots each inventoried by a herp array (center bucket, 3 5-m wings, and terminal funnel traps) for 10 consecutive nights and by Sherman traps (200 trap nights) sometime during the period 1 March 1996 to 31 October 2002 on an east Texas upland forest study area[b].

Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Acris crepitans	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Agkistrodon contortrix	_	_	_	1	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	1	_
Agkistrodon piscivorus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Anolis carolinensis	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_
Bufo houstonensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Bufo valliceps	_	_	_	_	_	_	1	_	_	1	_	1	1	_	_	_	1	1	_	_	_	1	1	_	_	_	_	1	1	_
Bufo woodhousii (*velatus*)	_	_	_	1	_	1	1	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Cnemidophorus sexlineatus	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_
Coluber constrictor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Diadophis punctatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Elaphe obsoleta	_	1	_	_	1	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Eumeces fasciatus	_	1	_	_	_	_	1	_	1	_	_	1	_	_	1	_	1	1	1	1	_	_	1	1	1	1	_	_	_	_
Eumeces laticeps	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	1	_	_	_
Eurycea quadridigitata	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gastrophryne carolinensis	1	_	_	1	1	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Gastrophryne olivacea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Heterodon platirhinos	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Hyla chrysoscelis	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hyla cinerea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lampropeltis calligaster	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Lampropeltis getula	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Masticophis flagellum	1	_	_	_	_	_	_	1	1	1	_	1	_	_	1	_	1	_	_	_	1	_	_	1	_	1	1	1	1	_

Appendix D (continued). Part 1: plots 1 to 45

Species	Plot																													
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Micrurus fulvius	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Nerodia erythrogaster	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Nerodia rhombifer	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Notophthalmus viridescens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Opheodrys aestivus	_	_	_	_	1	_	_	1	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Rana catesbeiana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Rana clamitans	_	_	1	_	1	1	_	_	_	1	1	1	1	_	_	1	_	1	_	_	_	_	1	_	1	_	_	_	1	_
Rana utricularia	_	_	1	_	_	_	_	1	_	_	_	_	_	1	_	1	1	1	_	_	1	_	1	_	_	_	_	_	_	_
Scaphiopus holbrookii	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_
Sceloporus undulatus	_	_	1	_	_	1	_	1	1	_	_	_	1	_	1	1	_	_	_	_	1	1	_	_	_	_	_	1	1	_
Scincella lateralis	1	1	1	1	1	1	1	1	1	1	1	_	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	_	1
Storeria dekayi	_	1	_	1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1
Tantilla gracilis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Thamnophis proximus	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	1	_	1	_	_	1	_	_
Virginia striatula	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Baiomys taylori	_	1	1	1	1	1	1	_	_	_	_	_	_	1	_	1	_	1	1	_	_	_	_	_	1	_	_	_	1	_
Blarina spp.	_	1	_	1	1	_	1	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_
Cryptotis parva	_	_	_	_	_	_	1	1	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Mus musculus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Neotoma floridana	1	_	_	_	_	_	_	1	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	1	_	1	_
Ochrotomys nuttalli	_	_	_	_	1	_	_	1	1	_	1	_	_	_	1	1	_	_	1	1	_	_	_	_	1	_	1	_	_	_
Peromyscus gossypinus	1	1	1	_	1	1	1	1	_	1	1	1	_	1	_	_	1	1	_	_	1	1	_	1	1	_	1	1	1	_
Peromyscus leucopus	_	_	_	_	_	1	_	1	1	_	_	1	1	1	1	1	_	_	_	_	1	1	_	1	_	_	1	1	_	_
Reithrodontomys fulvescens	_	1	_	1	1	_	1	_	1	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	1	_	_	_	_	_
Reithrodontomys humulis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Reithrodontomys montanus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sigmodon hispidus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_

Appendix D (continued). Part 2: plots 46 to 91

Species	Plot																												
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Acris crepitans	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Agkistrodon contortrix	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	1	_	1	_	_	1	1	1	_	_	_	_	_	_
Agkistrodon piscivorus	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Anolis carolinensis	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Bufo houstonensis	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Bufo valliceps	_	1	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	_	1	_	1	1	_	1	_	_	_
Bufo woodhousii (*velatus*)	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1
Cnemidophorus sexlineatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Coluber constrictor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Diadophis punctatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Elaphe obsoleta	1	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Eumeces fasciatus	_	_	1	_	_	1	1	1	1	_	_	1	_	_	1	_	1	_	_	1	_	_	_	1	_	1	_	1	1	_
Eumeces laticeps	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Eurycea quadridigitata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Gastrophryne carolinensis	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	1	_	_	1	1
Gastrophryne olivacea	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Heterodon platirhinos	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Hyla chrysoscelis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hyla cinerea	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lampropeltis calligaster	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lampropeltis getula	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Masticophis flagellum	_	_	1	1	_	1	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Micrurus fulvius	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_
Nerodia erythrogaster	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Nerodia rhombifer	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Notophthalmus viridescens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix D (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Opheodrys aestivus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rana catesbeiana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rana clamitans	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Rana utricularia	_	_	_	_	1	_	_	1	_	_	1	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Scaphiopus holbrookii	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sceloporus undulatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Scincella lateralis	1	1	1	_	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	_	1	1	1	1	1	1	1	1
Storeria dekayi	_	_	_	_	_	1	1	_	_	_	_	_	1	_	1	1	_	_	_	_	1	1	1	_	_	1	_	_	1	_
Tantilla gracilis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Thamnophis proximus	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	1	_	_	_	_	_	1	_	_	1	1	_
Virginia striatula	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Baiomys taylori	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	_
Blarina spp.	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Cryptotis parva	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1	1	_	_	_	1	1	1
Mus musculus	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Neotoma floridana	_	1	1	_	_	_	_	_	_	_	1	1	_	_	_	1	_	_	_	_	1	1	1	_	_	_	_	_	_	_
Ochrotomys nuttalli	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Peromyscus gossypinus	_	1	_	_	1	1	1	_	1	_	_	1	_	1	1	_	_	_	1	_	_	_	1	_	_	1	1	1	_	_
Peromyscus leucopus	_	_	_	1	1	_	1	1	1	_	1	1	1	1	1	1	1	1	_	_	_	_	1	1	1	1	1	_	_	1
Reithrodontomys fulvescens	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	1	_
Reithrodontomys humulis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Reithrodontomys montanus	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Sigmodon hispidus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_

[a] Herptile names follow Conant and Collins (1998). Mammal names follow Whitaker (1996)

[b] Plots are not numbered consecutively, but rather are named by number. Approximate plot locations and dates of inventories are in Table 1.

APPENDIX E

Spider (Araneae)[a] species presence (1) or absence (_) in 60 plots each inventoried by 1 pitfall trap with 3 5-m wings for 10 consecutive days sometime during the period 1 March 1996 to 31 October 2002 on an east Texas upland forest study area[b].

Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Agelenopsis aperta	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_
Agelenopsis emertoni	_	_	_	_	1	1	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Agelenopsis kastoni	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	1	_	_	_
Agelenopsis naevia	1	_	1	1	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	_
Agelenopsis spatula	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Allocosa retenta	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Allocosa sp. nr georgicola	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Anasaitis canosa	_	_	_	_	_	_	1	1	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Ariadna bicolor	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Barronopsis texana	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Bassaniana versicolor	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Callilepis imbecilla	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Castianeira amoena	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	1	_
Castianeira longipalpa	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Cesonia bilineata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cicurina sp. nr davisi	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cicurina sp. nr ludoviciana	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Cicurina sp. nr robusta	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cicurina sp. nr texana	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cicurina varians	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Coras sp. nr lamellosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dictyna formidolosa	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dolomedes albineus	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Dolomedes scriptus	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dolomedes tenebrosus	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Drassyllus aprilinus	_	1	1	_	_	_	_	1	_	1	_	_	_	_	1	1	_	_	1	_	1	_	_	1	_	_	1	_	_	_

Appendix E (continued). Part 1: plots 1 to 45

Species	Plot																													
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Drassyllus creolus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Drassyllus dixinus	1	1	1	1	_	_	1	_	_	1	1	_	_	_	_	_	1	1	1	1	_	_	_	_	_	_	_	_	_	_
Drassyllus dromeus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Drassyllus gynosaphes	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Drassyllus orgilus	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Drassyllus rufulus	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Elaver excepta	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Falconina gracilis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gasteracantha cancriformis	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gladicosa huberti	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gladicosa pulchra	_	_	_	_	1	1	_	_	_	_	_	_	_	1	_	_	1	1	_	_	_	_	_	1	_	_	_	_	_	_
Gnaphosa fontinalis	1	_	_	_	_	_	_	_	1	_	1	_	_	1	1	1	_	1	_	_	_	_	_	1	_	_	_	_	_	_
Gnaphosa sericata	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Habronattus sp. nr moratus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Herpyllus ecclesiasticus	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hogna helluo	_	1	1	1	1	1	_	1	_	1	1	_	_	1	1	_	1	1	1	_	1	_	_	1	1	1	_	_	1	1
Hogna sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Hogna sp. nr baltimoriana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Hogna sp. nr lenta	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Hogna sp. nr tigana	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hogna sp. nr watsoni	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_
Litopyllus temporarius	_	1	_	_	_	_	1	_	_	_	_	_	_	_	1	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_
Loxosceles reclusa	_	_	_	_	_	_	_	1	1	_	_	_	1	_	_	1	_	_	_	_	_	_	1	_	_	1	_	_	1	1
Mecynogea lemniscata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Metaltella simoni	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Myrmekiaphila fluviatilis	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Neoantistea oklahomensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Neoscona crucifera	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Oxyopes acleistus	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ozyptila modesta	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix E (continued). Part 1: plots 1 to 45

Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Phidippus audax	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Philodromus marxi	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Phrurotimpus borealis	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pirata alachuus	_	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pirata apalacheus	1	_	_	1	_	_	_	_	_	1	_	_	_	_	_	1	_	_	1	_	_	_	_	_	1	_	_	_	_	_
Pirata hiteorum	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Pirata seminolus	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pirata spiniger	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Pisaurina dubia	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Pisaurina mira	_	_	_	_	_	1	_	1	1	_	_	_	_	_	1	_	_	_	1	_	1	_	_	1	_	_	1	_	1	_
Rabidosa hentzi	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rabidosa punctulata	_	_	_	_	1	1	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	1	_
Rabidosa rabida	1	1	_	1	_	_	_	1	1	1	_	_	_	_	1	1	1	1	1	1	1	_	_	1	_	1	_	1	_	1
Schizocosa crassipes	1	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Schizocosa perplexa	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Schizocosa roverni	_	_	_	1	_	_	_	_	1	1	_	_	_	1	1	1	1	1	1	1	1	_	_	1	1	1	_	_	_	1
Schizocosa saltatrix	1	_	1	_	_	_	1	1	1	1	_	_	_	1	_	1	_	1	1	_	1	_	_	1	_	_	1	_	_	_
Schizocosa stridulans	_	1	_	_	_	_	1	1	_	1	1	_	_	1	1	1	1	1	1	1	_	_	_	_	_	1	_	_	_	_
Schizocosa uetzi	_	1	_	_	_	_	_	1	1	1	1	_	_	1	1	_	1	1	1	_	_	_	_	_	_	1	_	_	_	_
Scytodes sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sergiolus capulatus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sosticus insularis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	1	_	_	_	1
Steatoda americana	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Strotarchus piscatorius	_	_	_	_	_	_	_	1	_	_	_	_	_	1	1	_	1	_	1	_	1	_	_	1	_	_	_	_	_	_
Synaphosus paludis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Talanites exlineae	_	_	_	_	_	_	_	_	1	1	_	_	_	1	1	_	1	1	1	1	1	_	_	1	1	1	_	_	_	1
Titanoeca nigrella	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	1	_	_	_
Trochosa acompa	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Ummidia sp. 1	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Varacosa avara	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	_	1	_	1	1	_	1	_

Appendix E (continued). Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Xysticus ferox	1	1	_	_	_	_	_	1	1	_	1	_	_	_	1	1	_	1	1	1	1	_	_	_	_	1	1	_	_	_
Xysticus fraternus	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	1	_	_	_
Xysticus funestus	_	_	_	_	1	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Xysticus pellax	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_
Zelotes duplex	_	_	_	_	_	_	_	1	_	_	1	_	_	_	1	_	1	1	_	_	_	_	_	_	1	1	_	_	_	_
Zelotes hentzi	_	1	1	_	_	1	1	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	1	1
Zelotes lymnophilus	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Zelotes pseustes	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_

Appendix E (continued). Part 2: plots 46 to 91

	Plot																													
Species	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Agelenopsis aperta	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Agelenopsis emertoni	_	_	_	_	_	_	_	_	_	1	1	_	_	1	_	_	_	_	1	1	_	1	_	_	1	_	_	_	_	_
Agelenopsis kastoni	_	_	_	1	_	_	_	_	_	_	_	1	_	1	1	_	_	1	_	_	_	_	_	1	_	1	_	_	_	_
Agelenopsis naevia	_	1	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	1	_	_	_	1	1
Agelenopsis spatula	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Allocosa retenta	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Allocosa sp. nr georgicola	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Anasaitis canosa	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ariadna bicolor	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Barronopsis texana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Bassaniana versicolor	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Callilepis imbecilla	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Castianeira amoena	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	_	_	1
Castianeira longipalpa	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Cesonia bilineata	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix E (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Cicurina sp. nr davisi	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Cicurina sp. nr ludoviciana	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_
Cicurina sp. nr robusta	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Cicurina sp. nr texana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_
Cicurina varians	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Coras sp. nr lamellosus	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dictyna formidolosa	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dolomedes albineus	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Dolomedes scriptus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Dolomedes tenebrosus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Drassyllus aprilinus	1	_	_	1	_	_	1	_	_	_	_	1	_	1	_	1	1	1	_	_	_	_	1	1	_	1	1	1	_	_
Drassyllus creolus	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Drassyllus dixinus	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1
Drassyllus dromeus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Drassyllus gynosaphes	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_
Drassyllus orgilus	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Drassyllus rufulus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Elaver excepta	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Falconina gracilis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Gasteracantha cancriformis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gladicosa huberti	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Gladicosa pulchra	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	1	1	_	_	1	_	1	1	_	_	_	_	_	_
Gnaphosa fontinalis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gnaphosa sericata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Habronattus sp. nr moratus	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Herpyllus ecclesiasticus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hogna helluo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hogna sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hogna sp. nr baltimoriana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hogna sp. nr lenta	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix E (continued). Part 2: plots 46 to 91

Species	Plot																												
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Hogna sp. nr tigana	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Hogna sp. nr watsoni	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Litopyllus temporarius	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Loxosceles reclusa	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Mecynogea lemniscata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Metaltella simoni	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Myrmekiaphila fluviatilis	1	_	_	_	_	1	1	_	_	_	_	1	1	1	1	1	1	1	_	_	1	_	_	_	_	1	1	1	_	_
Neoantistea oklahomensis	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	1	_	1	_	1	1	_	1	_	_	_
Neoscona crucifera	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Oxyopes acleistus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ozyptila modesta	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Phidippus audax	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_
Philodromus marxi	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Phrurotimpus borealis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Pirata alachuus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pirata apalacheus	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Pirata hiteorum	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Pirata seminolus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pirata spiniger	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Pisaurina dubia	1	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Pisaurina mira	1	_	1	1	_	1	_	1	_	_	_	1	1	1	1	1	1	_	_	1	1	_	1	1	_	1	1	1	_	_
Rabidosa hentzi	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Rabidosa punctulata	_	_	_	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	1	1	_	_	_	_	1	_	_	_	_	_
Rabidosa rabida	_	1	1	_	_	1	1	_	1	_	_	1	1	1	1	1	_	_	_	_	1	_	_	_	_	_	1	_	1	_
Schizocosa crassipes	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Schizocosa perplexa	_	_	_	_	_	_	1	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Schizocosa roverni	1	1	1	_	_	_	1	1	1	_	_	1	1	1	1	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_
Schizocosa saltatrix	_	_	_	1	1	_	1	1	_	_	_	1	1	1	1	1	_	_	_	_	1	_	1	1	_	_	_	_	1	_
Schizocosa stridulans	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Schizocosa uetzi	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix E (continued). Part 2: plots 46 to 91

Species	Plot																												
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Scytodes sp. 1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sergiolus capulatus	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sosticus insularis	1	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Steatoda americana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Strotarchus piscatorius	1	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_	_
Synaphosus paludis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Talanites exlineae	1	1	1	_	_	1	1	_	1	1	_	1	1	1	_	_	_	_	_	_	_	_	1	_	_	_	1	1	1	_
Titanoeca nigrella	1	_	_	_	_	1	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	1	_	_
Trochosa acompa	1	_	_	_	_	_	_	1	_	_	_	1	_	1	1	_	_	_	_	_	1	_	_	_	_	_	1	1	_	_
Ummidia sp. 1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1
Varacosa avara	1	1	1	1	_	1	_	1	_	1	1	1	1	1	1	1	1	1	_	_	1	1	1	_	1	1	1	1	1	_
Xysticus ferox	_	_	1	1	_	1	1	1	1	_	_	1	1	1	1	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Xysticus fraternus	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_
Xysticus funestus	1	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	1	_
Xysticus pellax	_	_	_	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_
Zelotes duplex	_	1	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Zelotes hentzi	1	_	_	1	_	1	1	_	1	_	_	1	_	1	1	1	1	_	1	_	1	_	_	_	_	1	1	_	_	_
Zelotes lymnophilus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Zelotes pseustes	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

[a] Spiders were identified to species by Allen Dean, Entomology Department, Texas A&M University.

[b] Plots are not numbered consecutively, but rather are named by number. Approximate plot locations and dates of spider collections (i.e. herp array dates) are in Table 1.

APPENDIX F

Woody plant[a] species presence (1) or absence (_) in 60 1-ha plots each inventoried at least 3 times a year (spring, summer, fall) for 2 years during the period 1 March 1996 to 31 October 2002 on an east Texas upland forest study area[b].

Part 1: plots 1 to 45

	Plot																													
Species	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Acer rubrum	1	_	1	1	_	1	1	_	_	1	1	_	_	_	_	_	_	1	1	1	_	_	_	_	_	1	_	_	_	_
Amorpha paniculata	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ampelopsis arborea	_	1	1	1	1	_	1	_	1	1	1	_	_	_	1	1	_	1	1	1	_	_	_	_	1	1	_	_	_	_
Ampelopsis cordata	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Aralia spinosa	_	1	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Asimina parviflora	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Baccharis halimifolia	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1
Berchemia scandens	_	1	1	_	1	1	1	_	1	1	1	1	_	_	1	_	1	1	1	_	_	1	1	_	1	_	1	_	1	1
Bignonia capreolata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Buddleia lindleyana	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Bumelia lanuginosa	1	_	1	_	_	1	_	_	1	1	_	1	1	_	_	1	1	_	_	1	1	_	1	_	_	_	_	_	_	1
Callicarpa americana	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Campsis radicans	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	1	_	_	_	1	_	_	1	1	_	_	_	_
Carpinus caroliniana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Carya alba	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	1	1	_	_	_	_	_	1	_	_	_	_
Carya cordiformis	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Carya illinioensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Carya texana	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Castanea pumila	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Ceanothus americanus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Celtis laevigata	1	_	1	1	_	1	1	_	_	_	1	_	_	1	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_
Cercis canadensis	1	_	_	_	_	1	1	_	_	_	1	1	_	_	_	1	1	1	1	_	_	_	1	_	_	_	_	_	_	_
Chionanthus virginica	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Cornus florida	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	_	1	1	_	1	1	1	1	_
Crataegus crusgallii	_	1	_	1	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	1	_	_	_	_
Crataegus marshallii	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	1	1	1	_	_	_	_	1	1	_	_	_	1

Appendix F (continued). Part 1: plots 1 to 45

Species	Plot																													
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Crataegus spathulata	_	1	_	_	_	_	_	_	1	_	1	_	_	_	1	_	_	_	1	_	_	_	_	_	_	1	_	1	_	1
Crataegus uniflora	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Crataegus viridis	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_
Diospyros virginiana	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	_	1	_	1
Forestiera ligustrina	_	1	1	_	_	_	1	1	_	_	_	_	_	_	_	1	1	_	1	1	_	_	1	_	1	1	_	1	1	1
Fraxinus americana	_	_	_	1	1	_	1	_	1	1	_	_	_	1	_	1	1	_	1	1	_	_	1	_	_	1	_	_	_	1
Fraxinus pennsylvanica	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gelsemium sempervirens	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Gleditsia triacanthos	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	1
Ilex ambigua	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ilex decidua	_	1	1	1	_	_	1	_	_	_	1	_	_	_	_	_	1	1	_	_	_	_	_	_	1	_	_	_	_	1
Ilex montana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Ilex opaca	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	_	1	1	1	1	1	_	1	1	_	1	_
Ilex vomitoria	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Juglans nigra	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Juniperus virginiana	1	1	_	_	1	1	1	1	1	_	1	1	1	1	1	1	1	_	1	_	1	1	1	1	1	_	1	1	1	_
Lantana horrida	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ligustrum sinense	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_
Liquidambar styraciflua	1	1	1	1	1	1	1	1	1	1	1	_	_	1	1	1	1	1	_	1	_	1	1	1	_	1	_	1	1	_
Lonicera japonica	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Lonicera sempervirens	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Maclura pomifera	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Melia azedarach	_	1	_	1	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Morus rubra	_	1	1	1	_	1	1	_	_	1	1	1	_	_	1	1	1	1	1	1	1	1	1	1	_	1	_	1	1	1
Myrica cerifera	1	_	1	1	1	_	1	_	_	1	1	_	_	_	_	_	_	1	_	1	_	_	1	1	_	1	_	_	_	_
Nyssa sylvatica	1	1	1	_	_	1	1	_	_	1	1	_	_	_	1	_	_	_	1	_	_	1	_	1	_	1	_	1	1	_
Ostrya virginiana	_	1	1	1	_	_	1	_	_	_	1	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Parthenocissus quinquefolia	1	1	_	1	1	_	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	_	1	1	1	1	1	1
Pinus echinata	1	1	1	_	1	1	1	_	_	1	1	_	_	_	_	1	1	1	_	1	_	_	_	_	1	1	_	_	_	1
Pinus taeda	1	1	1	1	1	1	1	_	_	_	_	_	_	_	_	1	1	_	_	1	_	_	_	_	1	1	_	_	_	1

Appendix F (continued). Part 1: plots 1 to 45

Species	Plot 01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Prosopis glandulosa	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Prunus angustifolia	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Prunus caroliniana	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Prunus mexicana	_	1	1	1	1	_	1	_	_	1	1	_	_	_	_	_	1	_	1	1	_	1	_	_	1	1	_	_	_	1
Prunus serotina	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	1	1	1	1	1	_	_	_	1	1	1	_	_	_
Prunus umbellata	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Prunus virginiana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ptelea trifoliata	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Quercus alba	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_
Quercus falcata	_	1	1	1	1	1	1	_	_	1	1	_	_	1	1	1	1	1	1	1	_	_	_	1	1	1	_	1	_	1
Quercus incana	1	_	1	1	1	1	_	1	1	1	_	1	1	1	1	1	_	1	_	_	1	1	1	1	_	_	1	_	1	_
Quercus marilandica	1	_	1	_	1	1	_	1	1	1	1	1	_	1	_	1	_	1	1	_	1	1	1	_	_	_	1	1	1	1
Quercus nigra	_	1	1	_	1	1	1	1	1	1	1	1	_	1	1	1	1	1	_	1	1	_	1	_	1	1	1	1	_	1
Quercus phellos	_	1	_	1	1	1	1	_	_	1	1	_	_	_	_	1	1	_	1	_	_	_	_	_	1	1	_	_	_	1
Quercus shumardii	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Quercus stellata	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Quercus velutina	1	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_
Rhamnus caroliniana	_	1	_	1	_	1	1	_	_	1	1	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	1	_
Rhus aromatica	1	_	1	1	_	1	_	1	_	1	1	1	1	_	1	1	_	1	_	1	1	1	1	_	_	1	_	_	1	_
Rhus copallina	1	1	1	1	1	_	1	1	1	1	1	_	_	1	_	1	_	1	1	1	_	_	1	_	1	1	1	_	1	1
Rhus glabra	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Rubus aboriginum	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus apogaeus	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus arvensis	1	_	1	_	_	_	_	_	_	_	1	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	1	_	1
Rubus flagellaris	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_
Rubus louisianus	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_
Rubus lucidus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus persistens	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus riograndis	1	1	_	1	_	_	1	1	1	_	_	_	1	_	_	_	_	_	1	_	1	1	_	1	_	_	_	_	_	1
Sassafras albidum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	_	1	1	1	_	_	_	1	1	1	1	_

Appendix F (continued). Part 1: plots 1 to 45

Species	Plot																												
	01	02	05	06	07	08	10	12	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31	34	37	38	39	40	41	45
Smilax bona-nox	1	_	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Smilax glauca	1	_	1	_	1	1	1	1	1	1	1	1	1	_	1	1	_	1	_	1	_	1	_	1	_	1	_	1	1	_
Smilax laurifolia	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	_	1	_	_	_	1	1	_	_	1	1	1	1	1
Smilax rotundifolia	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Smilax tamnoides	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sophora affinis	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Symphoricarpos orbiculatus	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_
Symplocos tinctoria	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Tillia americana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Toxicodendron radicans	1	1	1	_	1	1	1	1	_	1	1	_	1	1	1	1	1	1	1	1	_	_	1	_	1	1	1	1	_	1
Toxicodendron toxicarium	_	_	1	1	1	1	_	_	1	_	_	1	_	_	_	1	_	_	_	_	1	1	_	_	_	_	_	_	1	_
Trachelospermum difforme	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	1	1	1	_	_	_	_	_	_	_	_	_	1
Ulmus alata	1	1	1	1	_	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ulmus americana	_	_	_	_	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ulmus crassifolia	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ulmus rubra	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Vaccinium arboreum	_	_	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Vaccinium corymbosum	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Viburnum nudum	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Viburnum rufidulum	1	_	1	_	1	_	1	_	_	1	1	1	_	_	1	1	1	1	1	1	_	1	_	_	_	1	1	1	1	1
Vitis aestivalis	_	1	_	_	1	_	1	_	_	1	_	_	_	_	_	_	_	1	1	1	1	_	_	_	_	1	_	_	_	_
Vitis cinerea	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Vitis lincecumii	1	_	1	1	1	1	_	1	1	_	1	1	1	1	1	1	_	1	_	1	1	1	1	1	_	_	1	_	1	_
Vitis mustangensis	1	_	_	_	1	1	1	1	1	1	_	_	_	_	_	1	_	_	_	_	1	_	1	_	_	_	1	1	_	_
Vitis riparia	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Vitis rotundifolia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Vitis vulpina	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	1	_	_	_	_	_	_	_	_	_	_	_
Zanthoxylum clava-herculis	1	1	1	1	_	1	_	_	1	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	1	1	_	1	_	_

Appendix F (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Acer rubrum	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Amorpha paniculata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ampelopsis arborea	1	1	1	_	_	_	1	1	1	_	1	_	1	1	1	1	1	1	_	1	_	1	1	_	_	_	1	1	1	_
Ampelopsis cordata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Aralia spinosa	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Asimina parviflora	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Baccharis halimifolia	_	_	1	_	_	_	1	1	1	_	_	_	_	1	1	_	_	_	1	_	1	_	_	_	_	1	_	_	1	_
Berchemia scandens	_	1	1	1	_	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	_	1	_	1
Bignonia capreolata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Buddleia lindleyana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Bumelia lanuginosa	1	_	_	1	1	1	1	1	1	_	1	1	_	1	_	1	1	_	_	1	_	1	1	1	_	_	_	_	1	_
Callicarpa americana	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Campsis radicans	_	1	1	_	_	_	1	1	_	_	1	_	_	1	_	_	_	_	_	_	1	_	1	_	1	1	_	1	1	1
Carpinus caroliniana	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Carya alba	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1
Carya cordiformis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Carya illinioensis	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Carya texana	1	1	1	_	1	1	_	1	1	1	_	1	_	1	1	1	_	_	1	1	1	_	_	_	1	1	1	1	1	1
Castanea pumila	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Ceanothus americanus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Celtis laevigata	_	_	_	_	_	_	1	1	_	_	1	1	1	1	_	_	1	_	_	_	_	1	1	_	_	_	_	1	1	_
Cercis canadensis	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_
Chionanthus virginica	_	1	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Cornus florida	_	1	1	_	1	_	_	1	1	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	1
Crataegus crusgallii	1	1	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	1	1	1	1	_	_	_	_	_
Crataegus marshallii	1	1	1	1	1	1	1	_	1	_	_	_	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1
Crataegus spathulata	1	1	_	1	_	_	1	_	1	_	_	1	_	1	_	1	1	_	_	_	_	_	1	_	1	1	_	1	1	_
Crataegus uniflora	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_
Crataegus viridis	_	_	_	1	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Diospyros virginiana	1	1	1	_	_	1	1	1	1	_	1	1	1	1	_	1	1	1	1	_	1	1	1	1	1	1	1	1	1	_

Appendix F (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Forestiera ligustrina	1	1	_	_	_	1	1	1	_	_	1	_	1	1	1	1	1	1	1	_	1	1	1	1	1	_	1	1	_	1
Fraxinus americana	1	1	1	_	_	1	1	1	_	_	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1
Fraxinus pennsylvanica	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Gelsemium sempervirens	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Gleditsia triacanthos	_	1	_	1	_	_	1	1	_	_	1	_	1	1	1	_	1	_	_	1	_	1	1	_	1	1	_	_	_	_
Ilex ambigua	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ilex decidua	_	_	_	1	_	_	1	1	1	_	1	1	1	1	_	1	1	1	_	1	1	1	1	1	_	1	_	_	_	_
Ilex montana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ilex opaca	_	1	1	_	1	1	_	_	_	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	1	1	1	1	1
Ilex vomitoria	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	_	1	1
Juglans nigra	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Juniperus virginiana	_	1	_	_	1	1	1	1	_	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	_	_	_	1	1
Lantana horrida	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ligustrum sinense	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Liquidambar styraciflua	_	1	1	_	1	1	_	1	1	_	_	_	_	1	1	_	_	_	_	1	_	_	_	_	_	1	1	1	1	1
Lonicera japonica	_	_	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	1	_	_	_	1	_	_	1
Lonicera sempervirens	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Maclura pomifera	_	_	_	_	_	_	_	_	_	_	1	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_
Melia azedarach	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_
Morus rubra	_	1	1	1	_	_	1	_	_	_	1	1	1	1	1	1	1	1	1	1	1	_	1	_	_	_	_	_	1	1
Myrica cerifera	1	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	_
Nyssa sylvatica	_	1	1	_	1	1	_	_	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	1	1	1
Ostrya virginiana	_	1	1	_	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	1	1
Parthenocissus quinquefolia	1	_	1	_	1	1	1	1	1	_	1	1	1	1	1	1	_	1	_	1	1	1	1	1	1	_	1	1	_	1
Pinus echinata	1	1	1	_	_	_	_	1	1	_	_	_	_	_	1	_	_	_	_	1	_	_	_	_	_	1	1	_	1	1
Pinus taeda	1	1	1	_	_	_	_	1	1	_	_	_	_	1	1	_	_	_	_	1	_	_	_	_	_	1	1	1	1	1
Prosopis glandulosa	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Prunus angustifolia	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Prunus caroliniana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_
Prunus mexicana	_	1	1	1	_	1	1	_	1	_	1	1	_	1	_	_	_	_	_	_	_	1	1	_	1	_	_	_	1	_

Appendix F (continued). Part 2: plots 46 to 91

Species	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
	Plot																													
Prunus serotina	_	1	1	_	_	_	1	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	1	_
Prunus umbellata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Prunus virginiana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Ptelea trifoliata	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Quercus alba	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Quercus falcata	1	1	1	_	_	1	1	1	1	_	_	_	1	1	1	_	_	_	_	1	_	_	_	_	_	1	1	1	1	1
Quercus incana	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_
Quercus marilandica	1	_	_	_	_	1	1	_	1	_	_	1	_	_	_	1	1	1	1	1	1	1	1	1	_	1	_	1	1	_
Quercus nigra	1	1	1	_	1	1	1	1	1	_	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Quercus phellos	_	1	1	_	_	_	1	1	1	_	1	_	1	_	_	_	1	_	1	1	_	1	_	_	1	1	_	1	1	1
Quercus shumardii	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Quercus stellata	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Quercus velutina	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Rhamnus caroliniana	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	1	_	_	1	1
Rhus aromatica	_	1	_	_	_	_	_	_	_	1	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_
Rhus copallina	1	_	1	_	_	_	_	1	1	_	_	_	_	1	_	1	_	_	_	1	1	_	_	1	_	_	_	_	_	_
Rhus glabra	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus aboriginum	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_
Rubus apogaeus	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus arvensis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus flagellaris	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus louisianus	_	_	_	_	_	1	_	1	_	_	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	1	1	_	_	_
Rubus lucidus	1	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus persistens	1	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Rubus riograndis	_	_	1	_	_	1	_	1	1	_	1	_	1	_	1	_	_	_	_	_	_	_	_	_	1	1	_	1	1	_
Sassafras albidum	_	1	1	_	1	_	_	1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_	1	1	1
Smilax bona-nox	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Smilax glauca	_	1	_	_	1	1	_	_	1	_	_	_	1	1	_	_	_	_	_	1	_	_	_	_	_	1	_	_	_	1
Smilax laurifolia	1	1	1	_	1	1	_	1	1	1	_	1	1	1	_	1	1	1	1	_	_	1	_	_	_	_	1	_	1	1
Smilax rotundifolia	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

Appendix F (continued). Part 2: plots 46 to 91

Species	Plot																													
	46	47	48	50	51	52	53	56	58	59	60	61	62	66	67	68	73	74	75	77	78	79	82	83	84	85	87	88	90	91
Smilax tamnoides	_	_	1	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Sophora affinis	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Symphoricarpos orbiculatus	_	_	_	1	_	_	1	_	_	_	1	_	_	_	1	1	1	1	_	1	1	1	1	1	1	_	_	_	_	_
Symplocos tinctoria	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Tillia americana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Toxicodendron radicans	1	_	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	_
Toxicodendron toxicarium	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Trachelospermum difforme	1	1	_	_	_	_	1	1	1	_	1	_	_	1	1	_	_	1	_	_	1	_	_	_	_	1	_	1	_	_
Ulmus alata	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ulmus americana	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Ulmus crassifolia	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Ulmus rubra	_	_	1	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1	_
Vaccinium arboreum	1	1	_	1	1	1	1	1	_	1	_	1	1	1	1	1	1	1	1	1	1	1	1	1	_	1	1	1	_	_
Vaccinium corymbosum	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Viburnum nudum	_	_	_	_	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Viburnum rufidulum	1	1	_	1	1	1	1	1	1	_	_	_	_	1	_	1	1	1	1	_	1	_	1	_	_	1	_	1	1	1
Vitis aestivalis	1	1	1	_	_	_	_	1	1	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	1	1	_	1
Vitis cinerea	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Vitis lincecumii	_	_	_	_	_	_	_	_	_	1	_	_	_	1	_	1	_	_	_	_	1	_	_	_	_	_	_	_	1	_
Vitis mustangensis	_	_	_	_	1	_	1	_	_	_	_	_	1	_	_	_	1	_	_	1	_	_	1	_	_	_	_	_	1	_
Vitis riparia	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	1
Vitis rotundifolia	1	1	1	1	1	1	1	1	1	1	_	1	1	1	1	1	_	1	1	1	1	1	_	1	_	1	1	1	1	1
Vitis vulpina	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_
Zanthoxylum clava-herculis	_	_	_	_	_	_	_	1	_	_	_	_	_	_	_	1	1	_	_	1	1	_	1	_	_	_	_	_	1	_

[a] Woody plant names follow Hatch et al. (1990)

[b] Plots are not numbered consecutively, but rather are named by number. Approximate plot locations are in Table 1.

VITA

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